# CITY OF CEDAR PARK

# TRANSPORTATION MASTER PLAN

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City of Cedar Park – Transportation Master Plan

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# INTRODUCTION AND BACKGROUND

## *Background*

The City of Cedar Park adopted a revised Roadway Plan in February of 1999. The plan showed both the current Major and Minor Arterial Roadway Classification plus projected necessary major and minor arterial roadways for future growth.

Cedar Park has grown rapidly since 1990 (more than doubling its own population) with the majority of population growth occurring since 1995. As a result, numerous changes have occurred in and around Cedar Park since the Roadway Plan was adopted in early 1999. The Planning Department is aware of the impact that rapid growth has made upon the city and has decided to revise and expand the 1999 Roadway Plan to preserve its utility for the changing environment of Cedar Park.

## *Purpose*

A more comprehensive document is needed beyond what was adopted in 1999. At the time, the roadway plan consisted of a map showing the current and potential locations of primary roadways. The Roadway Plan was adopted without benefit of description of specific roadways, anticipated travel demand, development timetables, design details for roadway cross sections, nor explanations of alternative modes, roadway maintenance and operations that would facilitate implementation and oversight of a roadway network.

In an effort to accommodate the current and future transportation needs of the City of Cedar Park, this document was drafted to provide more detail and direction regarding transportation issues. The Transportation Master Plan is to serve as a beginning point in the discussion of transportation issues. The plan is meant as a tool for transportation planning and not an 'answer book.'

## *Regional Growth Trends*

Central Texas has seen phenomenal growth within recent years and is expected to continue in the future. Much of this growth has been concentrated in Williamson County, directly impacting the City of Cedar Park's transportation resources. Table 1.1 shows the forecasted population for Williamson County as compared to the total forecasted population for the Capitol Area Metropolitan Planning Organization's (CAMPO) three county region: Hays, Travis and Williamson Counties.

The TMP is designed to work within the CAMPO planning process for the allocation of federal and state funds with respect to transportation improvements.

**Table 1.1: Regional Population Forecasts**

| | Williamson County | CAMPO Region |
|---|---|---|
| 2000 Census | 249,967 | 1,159,836 |
| 2007 Forecast | 347,054 | 1,326,337 |
| Percent Increase | 38.8% | 14.4% |
| 2015 Forecast | 510,106 | 1,650,179 |
| Percent Increase | 47.0% | 24.4% |
| 2025 Forecast | 802,989 | 2,213,441 |
| Percent Increase | 57.4% | 34.1% |

Source: CAMPO approved control totals as of September 10, 2001.

As with population, Williamson County's employment will grow at a faster rate than that of the CAMPO region. Table 1.2 lists the employment forecast for Williamson County as well as the entire CAMPO region.

**Table 1.2: Regional Employment Forecasts**

| | Williamson County | CAMPO Region |
|---|---|---|
| 1997 CAMPO | 52,400 | 515,500 |
| 2007 Forecast | 121,469 | 715,529 |
| % Increase | 131.8% | 38.8% |
| 2015 Forecast | 183,638 | 823,275 |
| % Increase | 51.2% | 15.1% |
| 2025 Forecast | 313,166 | 1,186,831 |
| % Increase | 70.5% | 44.2% |

Source: CAMPO approved control totals as of September 10, 2001.

The demographics used for Cedar Park projections were derived from the recent update to the Williamson County Demographic Forecast. These forecasts originated with the existing CAMPO demographics last updated in September of 2001. A review was conducted of proposed land development, existing zoning and undeveloped land to project estimates for the City of Cedar Park. Population and employment were then allocated in a proportionate relationship.

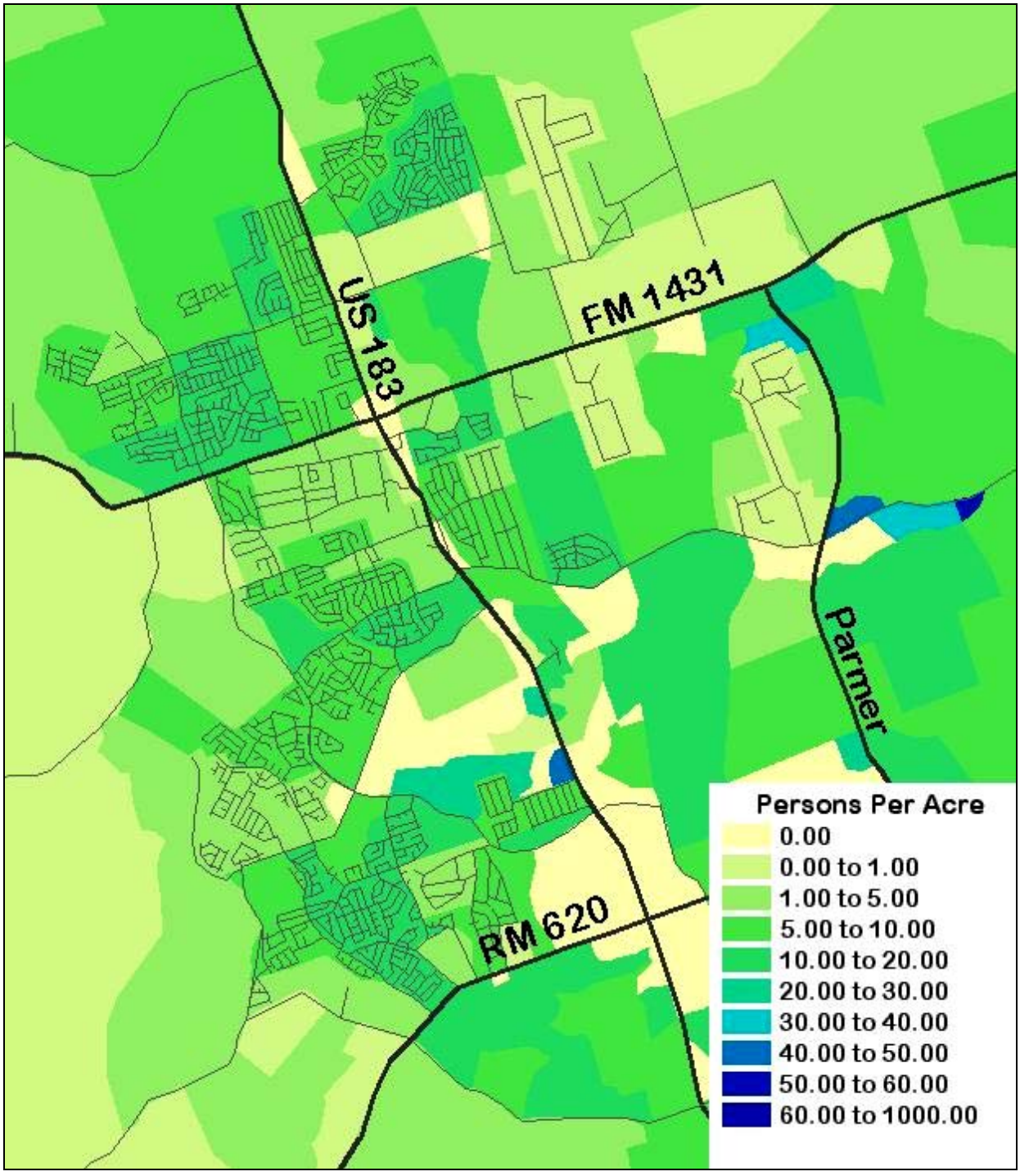
In the mid-1990's Cedar Park was identified as one of the fastest growing cities in Texas. This growth rate has continued and is not likely to decrease significantly in the foreseeable future. Table 1.3 shows current and forecast population figures for within the city limits and the total area, including the extra-territorial jurisdiction (ETJ). Figure 1.1 shows the anticipated population densities by the year 2025.

**Table 1.3: Cedar Park Forecasted Population**

| | Within City Limits | Within ETJ Limits |
|---|---|---|
| 2000 Census | 26,049 | *38,844 |
| 2007 Forecast | 47,088 | 65,018 |
| % Increase | 80.8% | 67.4% |
| 2015 Forecast | 61,723 | 92,001 |
| % Increase | 31.1% | 41.5% |
| 2025 Forecast | 74,685 | 114,447 |
| % Increase | 21.0% | 24.4% |

Source: Estimates based on the CAMPO 2001 demographic patterns. *The 2000 ETJ estimate is based on the Cedar Park Planning Department forecast in addition to the Census 2000 city population.

## Figure 1.1: 2025 Population Densities



## *Employment Forecasts*

Although population growth in Cedar Park has surpassed that of its employment, the city's business sectors have increased as well. Future projections anticipate that the growth rate of the area's employment sector will increase considerably in the next five to ten years.

Employment is divided into three sectors for the purposes of projecting growth: basic (manufacturing), retail (commercial), and service (office). Retail businesses usually quickly follow new housing developments. Schools, government and other institutional or service jobs follow. Future development holds possibilities for more basic (manufacturing and industrial) employment to be drawn to Cedar Park, as there are several areas within its boundaries zoned for such development.

Cedar Park has intensively developed west of Highway 183, far more than east of the freeway. Additional residential development east of both 183 and the proposed 183-A alignments will provide the opportunity for a more balanced residential and commercial traffic flow pattern across the city.

As the east side of Cedar Park becomes more densely populated, it should also see a rise in employment concentrations. Figure 1.2 shows the forecasted employees per acre in 2025 based on typical employment by type of business.

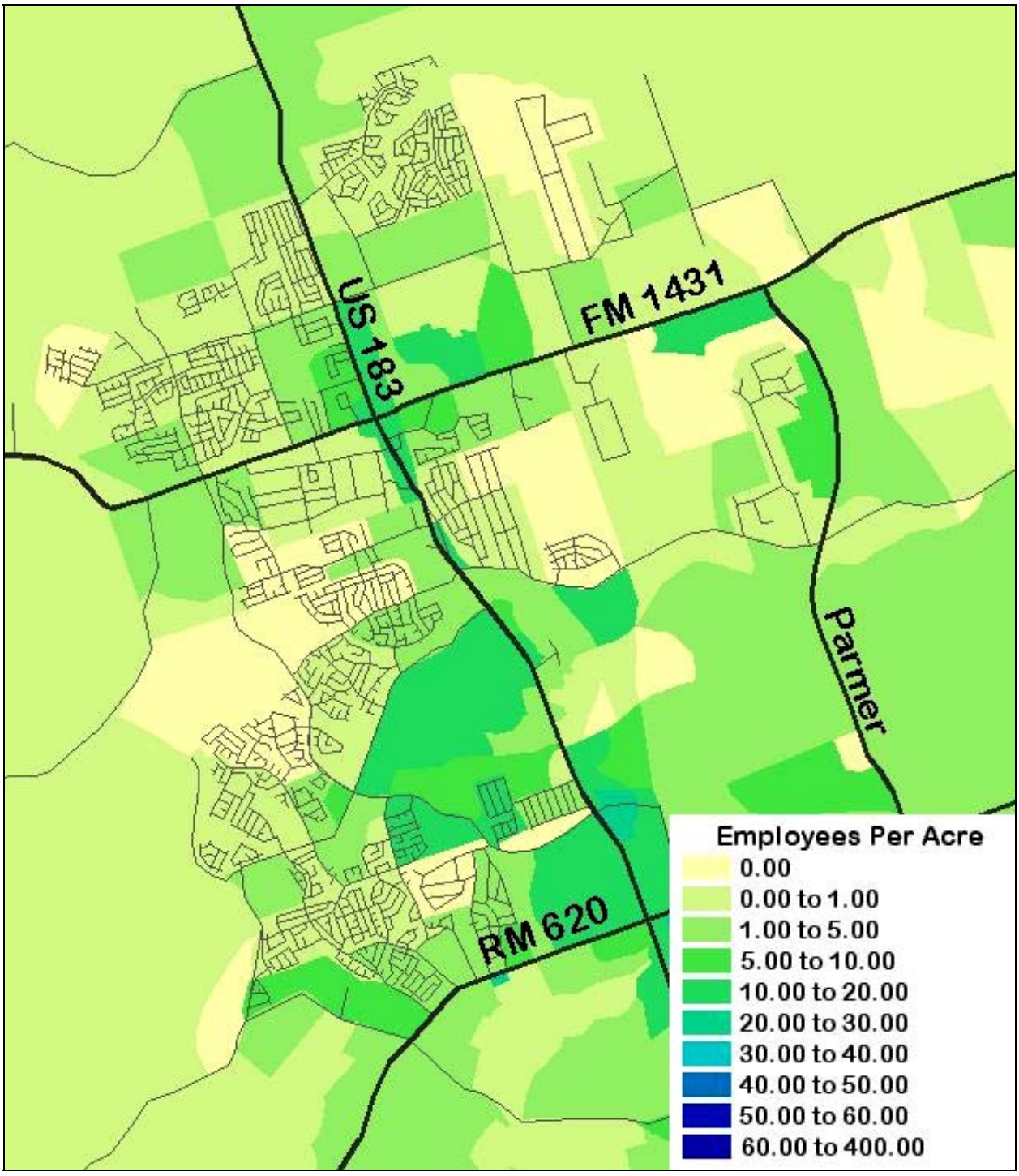
These trends will lead to more jobs and more in-town work trips. Table 1.4 shows the forecasted employment in Cedar Park and its ETJ out to the year 2025.

**Table 1.4: Cedar Park Employment Forecasts**

| | Within Current City Limits | Including Current ETJ Limits |
|---|---|---|
| 1997 CAMPO | 3,291 | 3,981 |
| 2007 Forecast | 17,584 | 24,196 |
| % Increase | 434.3% | 507.8% |
| 2015 Forecast | 25,352 | 33,819 |
| % Increase | 44.2% | 39.8% |
| 2025 Forecast | 32,079 | 41,564 |
| % Increase | 26.5% | 22.9% |

Source: Estimates based on the CAMPO 2001 demographics.

## Figure 1.2: 2025 Employment Densities



## *Previous Transportation Plan*

The previous Roadway Plan was essentially a map of current and anticipated major and minor arterials. The Transportation Plan was still under formulation while the City underwent unprecedented population growth and commercial development. It was quickly observed that a more detailed document would be necessary to address the transportation needs of Cedar Park.

## *Current Transportation Plan*

The nature of comprehensive transportation plans is fluid. The Cedar Park Transportation Master Plan documents the goals, objectives, elements and means by which transportation infrastructure and management will be addressed in the City of Cedar Park. It is anticipated that as Cedar Park grows periodic reviews and revisions to the Transportation Master Plan will become necessary. This document is not intended to provide encyclopedic reservoirs of knowledge. Instead, it is to serve as a first substantial step toward the development of an integrated, cohesive transportation management policy.

Given that the vast majority of transportation plans undergo extensive revision and review, it is suggested that the transportation master plan be scheduled for review and revision every three years. In light of the rapid growth Cedar Park has experienced and is anticipated to experience, a more aggressive schedule may prove necessary.

# GOALS AND OBJECTIVES

## *Purpose*

City planning goals serve to define the desired urban land uses, transportation, housing, and economic characteristics desired. They focus on problems of today as well as providing a framework for future development. By definition, transportation goals define a transportation system that would satisfy the needs of an existing population in a sustainable way.

This plan is based on the existing travel conditions within the city as well as the anticipated needs of the future. It seeks to serve adequately the needs of drivers while encouraging the development and use of a multi-modal transportation system.

Over time, Cedar Park will continue to develop local opportunities for entertainment, recreation and business pursuits. There will be increased need for internal connectivity and cross town transportation access. These future travel patterns should be anticipated and the appropriate infrastructure should be prepared.

The goals of the comprehensive plan are broad concepts addressing the different competing elements affecting Cedar Park's transportation system. The objectives break down those goals into more specific issues needed for implementation. The actions are suggested steps that can be taken to satisfy those objectives.

## *Current Transportation Issues*

**Mobility versus Accessibility**

As the main arterial into Austin, US Highway 183 heavily influences the City of Cedar Park's travel patterns. With the phenomenal growth the city has seen throughout the 1990's, this major arterial has been overburdened. In addition, other major roadways reflect the increased development of the region: Parmer Lane and FM 1431 experience daily congestion during peak travel periods.

The majority of trips passing through Cedar Park along major arterials are commuter trips. Roadway designs that once served the traveling public are no longer adequate. An urbanized area has grown up around an intercity highway and farm to market roadways, all of which were geometrically designed for fewer vehicles during peak periods.

With careful planning and a progressive financing scheme, Cedar Park can build the transportation system needed to serve the mobility and access needs of its residents and businesses. A successful arterial network is key to the success of this proposed system.

**Improved Safety**

Safety improvements should be made to Cedar Park's transportation system. While many accidents are due to driver error, there are ways to guide drivers and other users towards informed decisions. A responsible transportation system seeks to prevent as many accidents as possible.

**Alternative Travel Modes**

Cedar Park's interest in other travel modes beyond the private automobile is growing. Small sections of the City have made walking and bike riding more convenient for residents. Improving pedestrian and bicycle facilities is a large part of the Cedar Park Transportation Master Plan.

**Financing**

All available funding sources should be investigated to accomplish Cedar Park's transportation goals. This includes funding for maintenance and right-of-way preservation as well as new construction. The state and federal transportation agencies are good sources to consult regarding grants and funding assistance. Small municipal projects can have shared financial responsibilities with residential and business communities.

The City of Cedar Park will actively pursue funding from all available sources. These sources will include, but not be limited to, federal, state, local and regional funding initiatives. The sources will include, but not be limited to, the Texas Transportation Commission's Discretionary funds (Cat. 12 TTC Discretionary); the federal funding categories programmed by the Capital Area Metropolitan Planning Organization (CAMPO), which serves as the MPO for the Austin urbanized area; and any other local or regional transportation funding authorities.

The funding categories available through CAMPO are primarily centered on the STP 4(C) federal funds. The City will pursue projects that comply with and contribute to the plans and programs established by CAMPO including the Transportation Enhancement Program, Congestion Reduction Projects, and other projects eligible for federal funding.

Regional Mobility Authorities (RMA) are entities created by the State of Texas with the legal privileges to construct, maintain and operate toll roadways. Cedar Park should pursue the creation of a RMA for Williamson and Travis counties for the funding of future transportation facilities, specifically the US Highway 183-A toll roadway.

**Next Steps**

Cedar Park's existing and potential future congestion problems need to be addressed in a variety of ways. New roadways, roadway access management, traffic operations optimization, and future public transportation networks are all necessary elements for Cedar Park's transportation system. The following discussion of goals will help to provide guidance for the development of transportation policies and practices to improve the Cedar Park transportation system.

# Goal 1: Improve Mobility and Accessibility

The City of Cedar Park will work to create a roadway system that allows people to move within and through the city in an efficient manner without negatively impacting its citizens.

| | | | |
|---|---|---|---|
| Objective 1.1: | Prioritize the development, preservation and maintenance of the transportation network. | ***Action 1.1.1:*** | ***Work to create a pavement management system utilizing the city's GIS capabilities.*** |
| | | ***Action 1.1.2:*** | ***Continue a 5 year Capital Improvement Project schedule to improve the arterial network.*** |
| Objective 1.2: | Improve traffic flow along major arterials. | ***Action 1.2.1:*** | ***Limit curb cuts on planned arterial segments and work with existing property owners to consolidate and reduce existing curb cuts.*** |
| | | ***Action 1.2.2:*** | ***Provide adequate capacity along routes linking major destinations.*** |
| | | ***Action 1.2.3:*** | ***Develop an Access Management Plan, addressing problems needing attention and guidelines for future control of access.*** |
| Objective 1.3: | Improve congested intersections. | ***Action 1.3.1:*** | ***Maintain and optimize signal timing plans and create networks of signalized corridors.*** |
| | | ***Action 1.3.2:*** | ***Construct dedicated turn lanes and merge lanes where needed for intersections and driveways.*** |
| | | ***Action 1.3.3:*** | ***Review right-of-way acquisition for intersections of arterial roadways to allow for future capacity needs.*** |
| | | ***Action 1.3.4:*** | ***Review operational Levels of Service for critical intersections.*** |
| Objective 1.4: | Ensure emergency vehicles access. | ***Action 1.4.1:*** | ***Minimize actions that impede emergency vehicle movement.*** |
| | | ***Action 1.4.2:*** | ***Develop an Emergency Response Route Map.*** |
| | | ***Action 1.4.3:*** | ***Consider possible applications of ITS technologies to assist in the provision of EMS services (e.g. signal preemption).*** |

| | | |
|---|---|---|
| Objective 1.5: | Improve access to the major arterial network. | ***Action 1.5.1:*** ***Identify collectors and minor arterials that will support and feed the major arterials.*** |
| | | ***Action 1.5.2:*** ***Develop an arterial network that will connect to Parmer Lane and US 183-A.*** |
| | | ***Action 1.5.3:*** ***Develop a system of arterials on the east side of Cedar Park.*** |
| Objective 1.6: | Minimize the peak period traffic demands. | ***Action 1.6.1:*** ***Encourage businesses to support flextime, job sharing, and staggered work hours (e.g. 9/80 schedules).*** |
| | | ***Action 1.6.2:*** ***Encourage public participation in programs that reduce travel demand (e.g. Commute Solutions, RideShare).*** |
| Objective 1.7: | Cooperate with other municipalities when planning new roadways. | ***Action 1.7.1:*** ***Continue involvement in the Capital Area Metropolitan Planning Organization.*** |
| | | ***Action 1.7.2:*** ***Work directly with adjacent municipalities and government agencies to coordinate transportation improvements.*** |
| | | ***Action 1.7.3:*** ***Examine feasibility of Regional Mobility Authorities (RMA's) for the Central Texas Region.*** |
| | | ***Action 1.7.4:*** ***Pursue construction of US Highway 183-A as a toll facility serving the Central Texas region.*** |
| | | ***Action 1.7.5:*** ***In cooperation with the City of Austin, Williamson County and TxDOT aggressively pursue construction of Lake Creek Parkway from FM 1431 to Avery Ranch Blvd.*** |
| | | ***Action 1.7.6:*** ***In cooperation with TxDOT, Williamson County and Travis County, aggressively pursue construction of Anderson Mill Road from FM 1431 to RM 620.*** |

Objective 1.8: Improve connectivity of subdivisions with parks, school campuses and other neighborhoods.

***Action 1.8.1:*** ***Involve neighborhood groups, developers and local schools in developing a route plan emphasizing pedestrian and bicycle modes.***

***Action 1.8.2:*** ***Strongly encourage developers to provide pedestrian and bikeway access.***

***Action 1.8.3:*** ***Encourage schools to develop bus routes that minimize the use of major arterials.***

***Action 1.8.4:*** ***Enforce Planning and Zoning policies regarding block length, intersection and roadway spacing to preserve adequate and reasonable access.***

# Goal 2: Increase Safety

Cedar Park will work to improve the safety of the transportation system including the physical aspects as well as law enforcement. In addition, driver education should be encouraged to help develop a transportation system where all modes interact in a safe manner.

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|---|---|---|---|
| Objective 2.1: | Identify and address intersections of concern. | ***Action 2.1.1:*** | ***Produce an annual report on the most frequent traffic incident locations and recommended improvements.*** |
| | | ***Action 2.1.2:*** | ***Prioritize highest crash locations and implement a systems improvement program to address and eliminate the causes.*** |
| Objective 2.2: | Identify and remedy constrained points of access from driveways as well as traffic lanes. | ***Action 2.2.1:*** | ***Work with property owners to develop an Access Management Plan.*** |
| | | ***Action 2.2.2:*** | ***Construct raised medians to control movement of commercial traffic where necessary and appropriate.*** |
| | | ***Action 2.2.3:*** | ***Develop and enforce turn lane policies for 2-way left turn lanes.*** |
| Objective 2.3: | Identify and address areas of difficult or poor visibility. | ***Action 2.3.1:*** | ***Provide adequate street lighting and signage.*** |
| | | ***Action 2.3.2:*** | ***Enforce code requirements regarding intersection clear zones and sight lines (sight triangle ordinance).*** |
| Objective 2.4: | Identify locations where traffic laws are frequently violated. | ***Action 2.4.1:*** | ***Coordinate with Police and Public Safety personnel for increased law enforcement.*** |
| | | ***Action 2.4.2:*** | ***Apply passive control measures such as speed wagons or informants.*** |
| | | ***Action 2.4.3:*** | ***Consider use of ITS technologies for automated traffic law enforcement.*** |

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|---|---|---|---|
| Objective 2.5: | Identify areas where traffic control measures could better guide the actions of the driver. | ***Action 2.5.1:*** | ***Provide adequate signage for no parking zones, bicycle routes, and pedestrian crosswalks.*** |
| | | ***Action 2.5.2:*** | ***Provide extra law enforcement in school zones.*** |
| | | ***Action 2.5.3:*** | ***Create a citizen's traffic advisory committee or a traffic issues forum for public discussion.*** |
| Objective 2.6: | Improve the safety of at-grade railroad crossings. | ***Action 2.6.1:*** | ***Where appropriate and feasible, grade separate arterials at railroads.*** |
| | | ***Action 2.6.2:*** | ***Continually monitor and ensure adequate visibility and signage at railroad crossings.*** |
| | | ***Action 2.6.3:*** | ***Examine benefits of advance warning and similar improvements for at-grade railroad crossings.*** |
| Objective 2.7: | Reduce the inappropriate use of residential and collector streets. | ***Action 2.7.1:*** | ***Develop a comprehensive residential traffic management policy.*** |
| | | ***Action 2.7.2:*** | ***Complete interconnecting roadways to help to disperse traffic.*** |
| Objective 2.8: | Ensure the safe parking of vehicles on roadways. | ***Action 2.8.1:*** | ***Develop a parking plan to identify acceptable on-street parking policies.*** |
| | | ***Action 2.8.2:*** | ***Periodically review the parking plan for implementation and enforcement.*** |
| | | ***Action 2.8.3:*** | ***Properly mark and enforce prohibited parking areas.*** |
| | | ***Action 2.8.4:*** | ***Encourage the development of adequate off-street parking facilities.*** |
| Objective 2.9: | Minimize the conflict between through traffic and school zones. | ***Action 2.9.1:*** | ***Encourage schools to develop routes that minimize the use of major arterials.*** |
| | | ***Action 2.9.2:*** | ***Construct necessary transportation infrastructure to support schools and school access routes (e.g. school zones, markings, crosswalks).*** |

# Goal 3: Promote Alternative Travel Modes

Cedar Park should offer and encourage the use of travel modes other than the automobile. Citizens should be encouraged to use bicycles, walking, and public transit as alternatives.

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| Objective 3.1: | Provide convenient and safe bicycle routes. | ***Action 3.1.1:*** | ***Develop a Cedar Park Bikeway Policy.*** |
| | | ***Action 3.1.2:*** | ***Improve existing roadways identified as bicycle accessible facilities.*** |
| | | ***Action 3.1.3:*** | ***Review future roadways for potential bicycle use and require additional right of way to be provided where necessary.*** |
| | | ***Action 3.1.4:*** | ***Limit the conflicts between on-street parking and bicycle lanes.*** |
| | | ***Action 3.1.5:*** | ***Encourage development of bicycle friendly 'end of trip' facilities: storage lockers, parking racks, etc.*** |
| Objective 3.2: | Provide attractive and convenient access routes for pedestrians. | ***Action 3.2.1:*** | ***Require new residential and commercial developments to provide sidewalks.*** |
| | | ***Action 3.2.2:*** | ***Connect existing sidewalks to create continuous pedestrian paths.*** |
| | | ***Action 3.2.3:*** | ***Encourage development and placement of interconnecting trails and pathways for pedestrian access.*** |
| Objective 3.3: | Minimize conflict between travel modes. | ***Action 3.3.1:*** | ***Clearly designate walkways and bikeways from the automobile travel lanes.*** |
| | | ***Action 3.3.2:*** | ***Require the installation of pedestrian signals and call buttons during signal installation.*** |
| | | ***Action 3.3.3:*** | ***Consider constructing pedestrian-bicycle overpasses or underpasses across major roadways.*** |
| | | ***Action 3.3.4:*** | ***Install proper signage to alert drivers of pedestrian crossings and points of shared access.*** |

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|---|---|---|
| Objective 3.4: | Support the provision of public transportation. | ***Action 3.4.1:*** ***Encourage development of shared transportation services (Rideshare, Commute Solutions, etc).*** |
| | | ***Action 3.4.2:*** ***Cooperate with Capital Area Rural Transportation System (CARTS) during regional needs assessment study.*** |
| | | ***Action 3.4.3:*** ***Work with Capital Metro to provide appropriate public transportation services for Cedar Park.*** |
| | | ***Action 3.4.3:*** ***Encourage construction of higher density developments, which support multiple travel modes.*** |
| | | ***Action 3.4.5:*** ***Review opportunities to provide intermediate transit services (taxi services, Para transit services, shuttle systems, etc.)*** |

# Goal 4: Balance Financial Responsibility

Cedar Park should plan, construct, and maintain the transportation system in a financial manner that does not overburden the public yet provides an efficient network of travel options.

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|---|---|---|---|
| Objective 4.1: | Expand the pursuit of State and Federal funding for transportation projects. | ***Action 4.1.1:*** | ***Submit candidate projects for Metropolitan Planning Organization (MPO) funding.*** |
| Objective 4.2: | Promote innovative financing methods for transportation system improvements. | ***Action 4.2.1:*** | ***Consider proposing transportation impact fees for off-site improvements due to traffic impact.*** |
| | | ***Action 4.2.2:*** | ***Leverage local sales tax revenue for transportation bond funding.*** |
| | | ***Action 4.2.3:*** | ***Support the construction of major toll way facilities.*** |
| Objective 4.3: | Maximize lifespan of system improvements. | ***Action 4.3.1:*** | ***Require design and construction of roadways to acceptable standards.*** |
| | | ***Action 4.3.2:*** | ***Consider transportation system maintenance a high priority in annual budgets.*** |
| Objective 4.4: | Provide for possession of future rights of way in the most fiscally responsible manner possible. | ***Action 4.4.1:*** | ***Develop a Right of Way Acquisition Plan that will enable the city to acquire right of way.*** |
| | | ***Action 4.4.2:*** | ***Develop and enforce minimum and maximum right of way requirements for new developments.*** |
| Objective 4.5: | Minimize the costs of future improvements. | ***Action 4.5.1:*** | ***Encourage that utilities be placed according to ultimate build-out scenario to limit the relocation costs.*** |
| | | ***Action 4.5.2:*** | ***Commit to a fixed schedule for CIP transportation improvements.*** |
| Objective 4.6: | Consider non-traditional methods of providing land for alternative travel means. | ***Action 4.6.1:*** | ***Consider negotiating the usage of utility rights of way for bicycle and pedestrian improvements.*** |

# Goal 5: Limit Environmental Impacts

Cedar Park should plan, construct, and maintain the transportation system in a manner that does not adversely impact the environmental health and quality of public spaces.

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|---|---|---|---|
| Objective 5.1: | Limit impact to local and regional water quality. | ***Action 5.1.1:*** | ***Require developments to comply with local, regional and federal environmental regulations.*** |
| | | ***Action 5.1.2:*** | ***Consider impervious cover and storm water runoff when reviewing proposed roadway alignments.*** |
| Objective 5.2: | Limit impact of developments upon declared historic or architectural landmarks. | ***Action 5.2.1:*** | ***Consider proposing development environmental impact fees and submittal of environmental impact reports (EIR) for large scale developments.*** |
| | | ***Action 5.2.3:*** | ***Review proposed developments in light of operational impacts as well as physical obstructions.*** |
| Objective 5.3: | Minimize cost of environmental mitigation efforts resulting from additional development. | ***Action 5.3.1:*** | ***Review required improvements with respect to the city as a whole to determine const effective means of environmental impact mitigation.*** |
| | | ***Action 5.3.2:*** | ***Consider transportation system maintenance a high priority in annual budgets.*** |
| Objective 5.4: | Limit impact to air quality in Cedar Park. | ***Action 5.4.1:*** | ***Encourage development of transportation infrastructure that minimizes points of congestion and provides adequate access.*** |
| | | ***Action 5.4.2:*** | ***Encourage interconnected roadway networks to disperse residential and commercial traffic volumes.*** |
| Objective 5.5: | Develop internal expertise to review environmental impact of developments. | ***Action 5.5.1:*** | ***Review developments in an integrated and consistent manner to encourage compliance with the overall environmental objectives of Cedar Park.*** |

## Resources

*2001 Regional Transportation Plan for the San Francisco Bay Area*
San Francisco Bay Area Metropolitan Transportation Commission
Oakland, California
http://www.mtc.ca.gov/projects/rtp/rtpindex.htm

*2025 Regional Transportation Plan*
Pima Association of Governments
Tucson, Arizona
http://www.pagnet.org/TPD/RTP/

*Arterial and Collector Street Plan*
City of Eugene
Eugene, Oregon
http://www.ci.eugene.or.us/Pw/trans/ACSP/

*City of Richmond's Master Plan June 2000 (Draft)*
City of Richmond
Richmond, Virginia
http://www.ci.richmond.va.us/ecitizen/documents/index.htm

*Greater Bozeman Area Transportation Plan 2001*
City of Bozeman
Bozeman, Montana
http://www.bozeman.net/planning/TransPln/Intro.htm

*James City County Comprehensive Plan*
James City County Planning Division
James City County, Virginia
http://www.james-city.va.us/about/complan.html

*Spokane Metropolitan Transportation Plan*
Spokane Regional Transportation Council
Spokane, Washington
http://www.srtc.org/Metropolitan%20Transportation%20Plan.htm

*Stafford County Transportation Plan*
Stafford County Department of Planning and Community Development
Stafford County, Illinois
http://www.co.stafford.va.us/planning/transplan.htm

*Vision 2020 – Dane County Land Use and Transportation Plan*
Dane County Regional Planning Commission
Dane County, Wisconsin
http://www.co.dane.wi.us/vis2020

*Will County 2020 Transportation Frame Work Plan*
Will County Lane Use Department
Will County, Illinois
http://www.willcounty-landuse.com/trans/trans.html

# ROADWAY PLANNING

## *Background*

The City of Cedar Park possesses an eclectic mix of major and minor roadways. The network of roadways reflects the development pattern of quiet, residential neighborhoods and commercial business centers. In modern parlance, the roadway and land development patterns of the City of Cedar Park reflect its status as a "bedroom community" of the greater metropolitan region.

The current roadway network serves large scale housing developments with direct connections to high volume roadways within the arterial network. In many locations, there are few means to access a given destination and frequently all the drivers are required to use the same access points.

There is a need to provide greater connectivity within and across Cedar Park. In locations with primarily residential developments, interconnecting streets should be placed strategically to allow for dispersal of internal traffic. Major commercial developments should have well positioned points of access and clearly defined internal flow patterns to ensure against inefficient or confusing designs. Arterials and freeways will need considerable improvement to their capacities and operations to ensure smoother traffic flow and easier access.

## *Planning for Future Demand*

Ideally, a planning document should address the most pressing concerns as well as anticipate future problems. However, anticipating these future needs is difficult; not all future transportation conflicts can be estimated.

## *Estimating Travel Demand*

In order to forecast future travel patterns, a careful study of current travel patterns is conducted. These observations in combination with defensible assumptions regarding demographic, regional and economic trends are used to create estimates of future travel demands.

Computer simulation programs are able to take the demographic forecasts and estimate future automobile demand on the roadways or demands on alternative transportation modes. It is important to remember that these figures are estimates.

Figures and maps presented on the following pages will provide additional detail regarding the nature of travel patterns within the City of Cedar Park.

## *Summary of Modeling Techniques*

The future traffic projections were forecast via a multi-step computer process referred to as travel demand modeling. In addition to reviewing traffic patterns on a daily basis, particular hours can be reviewed, such as morning and evening rush hours. Time of day modeling can estimate traffic volumes during a particular time-period based on historical travel patterns.

Travel demand models were produced for the City of Cedar Park during the roadway priority review for the Capital Improvement Projects. This study projected traffic volumes for the years 2007, 2015 and 2025. In addition, peak hour volumes were reviewed for the AM and PM peak 3-hour periods. The results were used to identify future potentially congested areas in the city.

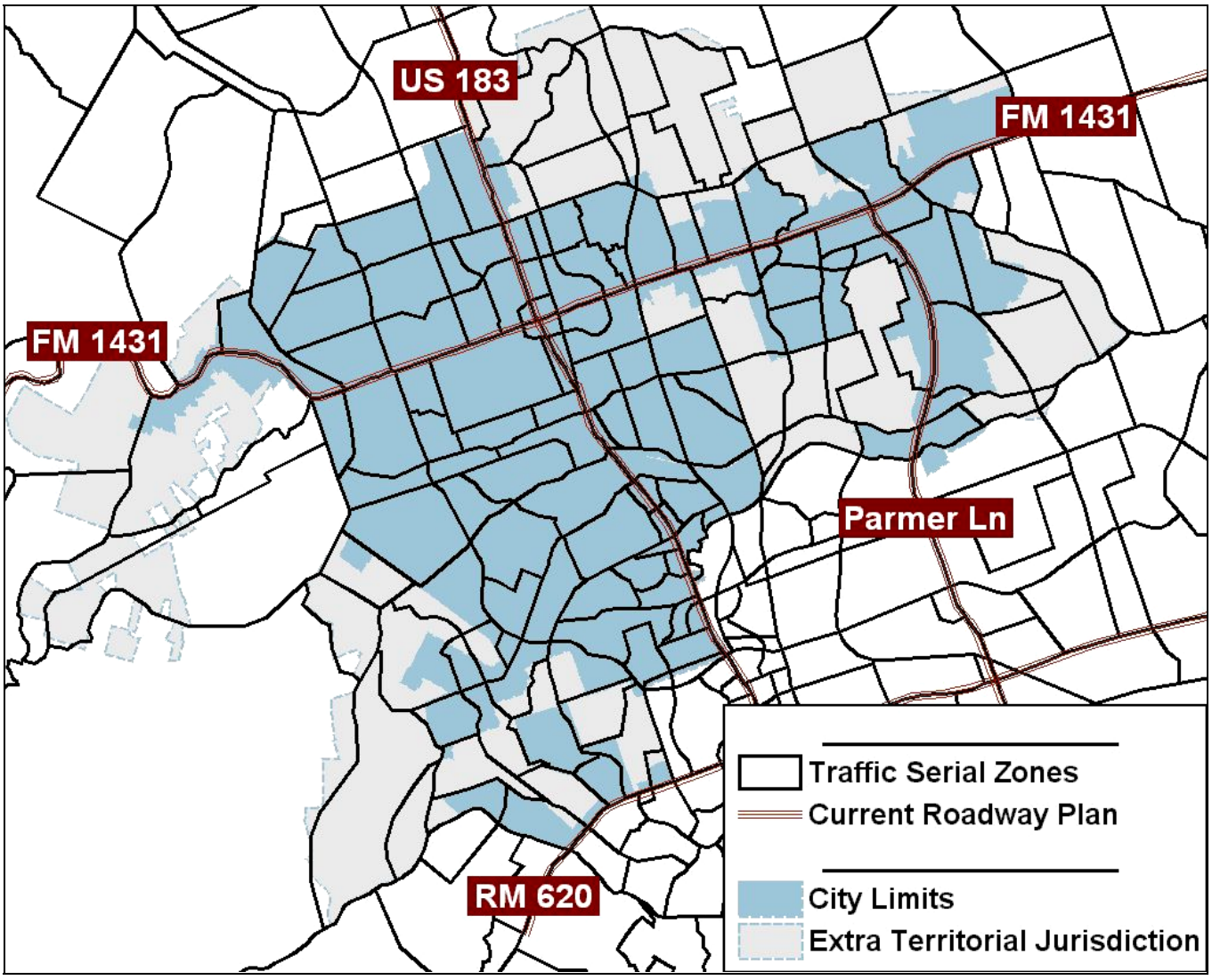
Since travel demand models estimate traffic movement based on a trip's origin (e.g. the location of a household) and its destination (work, school, shopping, etc.), it was important to revise the existing CAMPO model zone structure to reflect the different housing developments and local destinations. This was done by refining or reducing the existing zone structures. Figure 3.1 illustrates the final result.

Greater detail in the roadway network resulted in better estimation of future volumes on many of Cedar Park's roads. Only a summary of these findings is reviewed in this section. For a more detailed report of the study, please refer to the June 2001 Cedar Park Capital Improvement Program Support document.

After the regional transportation modeling study in 2001, modifications were made to the Cedar Park Roadway Plan. The changes included additional roadways and the reclassification of some existing roadways. Adopted in April of 2002, the revised City Roadway Plan is included in this document as Figures 3.6 and 3.7. Figure 3.6 is the network of collector streets. Figure 3.7 is the network of arterial roadways.

However, the prior version of the roadway plan was used in the model, represented in Figures 3.1 through 3.3. Therefore not all currently proposed roadways are shown in the figures. Future modeling efforts will continue to use the most recently available adopted roadway plan for network analysis.

**Figure 3.1: Cedar Park Traffic Serial Zones**



## *Future Traffic Volumes*

Estimating future congestion allows site plans to be developed and reviewed with an eye towards increasing traffic demands. The future year estimates for Cedar Park contained two scenarios: one with its planned roadway system in place and one with future population estimates using the existing roadway system. The city's most congested areas were identified and prioritized.

One of the main issues facing Cedar Park's future congestion levels is the construction of the US 183-A toll facility. This roadway will play a major role in whether future traffic will move through or around Cedar Park. For this reason, future traffic volumes on Cedar Park's roadways were tested with and without the facility. Both scenarios were forecast for the 2007, 2015 and 2025 future conditions. By doing this, a "worst-case" scenario was reviewed without the toll way, which allows Cedar Park to make contingency plans that would help existing US 183 traffic.

In general, daily traffic volumes in Cedar Park are expected to increase, possibly double, by as early as 2007 even with the proposed improvements. The construction of US 183-A will influence these numbers dramatically. With the construction of new subdivisions on Parmer, average daily traffic volumes are forecast to reach as much as 38,000 by 2007. This same segment of Parmer Lane has forecast volumes under 29,000 if US 183-A is built.

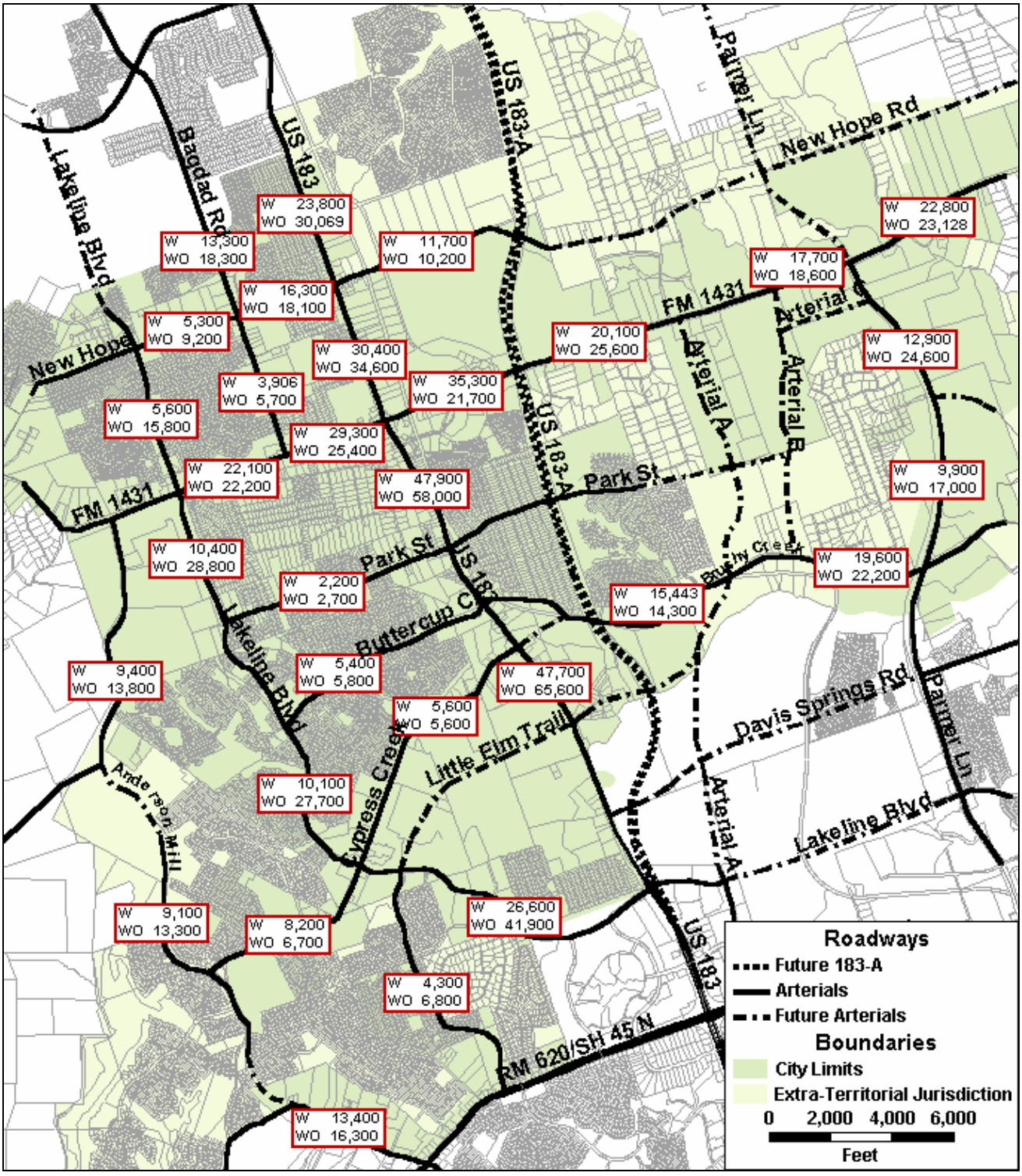
Parmer is not the only roadway that will be affected by the presence or absence of the US 183-A toll facility. Figure 3.2 shows the projected volumes for 2007 with expected future roadways in place. Both scenarios, with and without US 183-A, are presented on this map.

## *Additional Local Roadways*

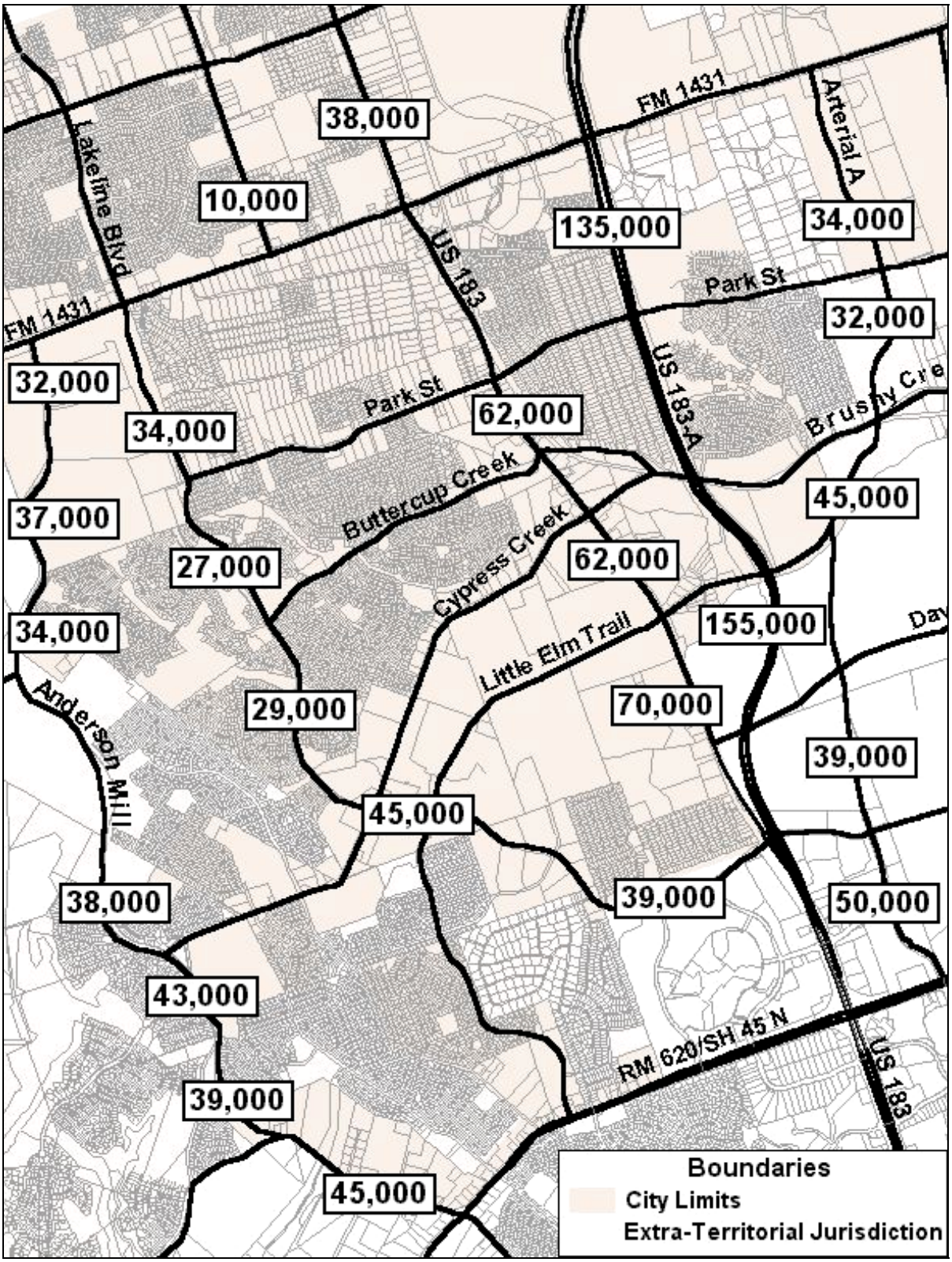
With traffic volumes expected to increase significantly by the year 2025, Cedar Park has planned many roadway improvements in anticipation. In addition to US 183-A, proposed new roadways Arterial A and Anderson Mill Road will provide relief to the city's congested roadways.

By 2025, these two roads are expected to remove over 80,000 trips off other roadways. Figure 3.3 illustrates the extent of change to anticipated travel patterns provided by the proposed north-south arterials, including US 183-A. Without the proposed roadways, traffic would be forced to use other routes, such as the current US Highway 183 and Lakeline Boulevard.

## Figure 3.2: 2007 Daily Traffic Volumes



## Figure 3.3: 2025 Daily Traffic Volumes



### *Evaluating Traffic Flows*

When traffic volumes on local roads increase, vehicle flow rates decrease. The quality of the flow rate of a given road is evaluated in terms of Level of Service (LOS). The LOS is a ratio of the volumes on the roadway to its traffic capacity. These ratios are then given a "letter grade" that groups and characterizes these ratios within the roadway's traffic stream. The six LOS classifications represent the following traffic conditions:

- **LOS A** – Free flow conditions, minimal interaction with other vehicles
- **LOS B** – Reasonably unconstrained movement, slight decline in average speeds
- **LOS C** – Speed selection is affected, maneuvering requires vigilance and caution
- **LOS D** – High density flow, travel speeds and maneuverability is severely restricted by presence of other vehicles
- **LOS E** - Operating conditions at capacity; no gaps in the traffic stream
- **LOS F** - Forced traffic flow or "grid lock" conditions.

As the LOS scale is an attempt to rate the quality of flow, different drivers will have different interpretations of the various levels. Cedar Park will attempt to operate all roadways and intersections at LOS D or better.

Roadways in Cedar Park will likely reach and surpass their capacity by the year 2025. The majority of Cedar Park's roadways are projected to operate at a "LOS F" due to the anticipated increases in population and employment.

In light of the anticipated burdens on the roadway network, the city of Cedar Park will continue to pursue, propose, and develop ways to minimize congestion. Future opportunities to widen intersections and realign roadways will be carefully examined in order to provide improved operations, such as the construction of dedicated right and left turn lanes, improved signal timing plans and restricting access from adjacent land developments.

## *Regional Roadway Improvements*

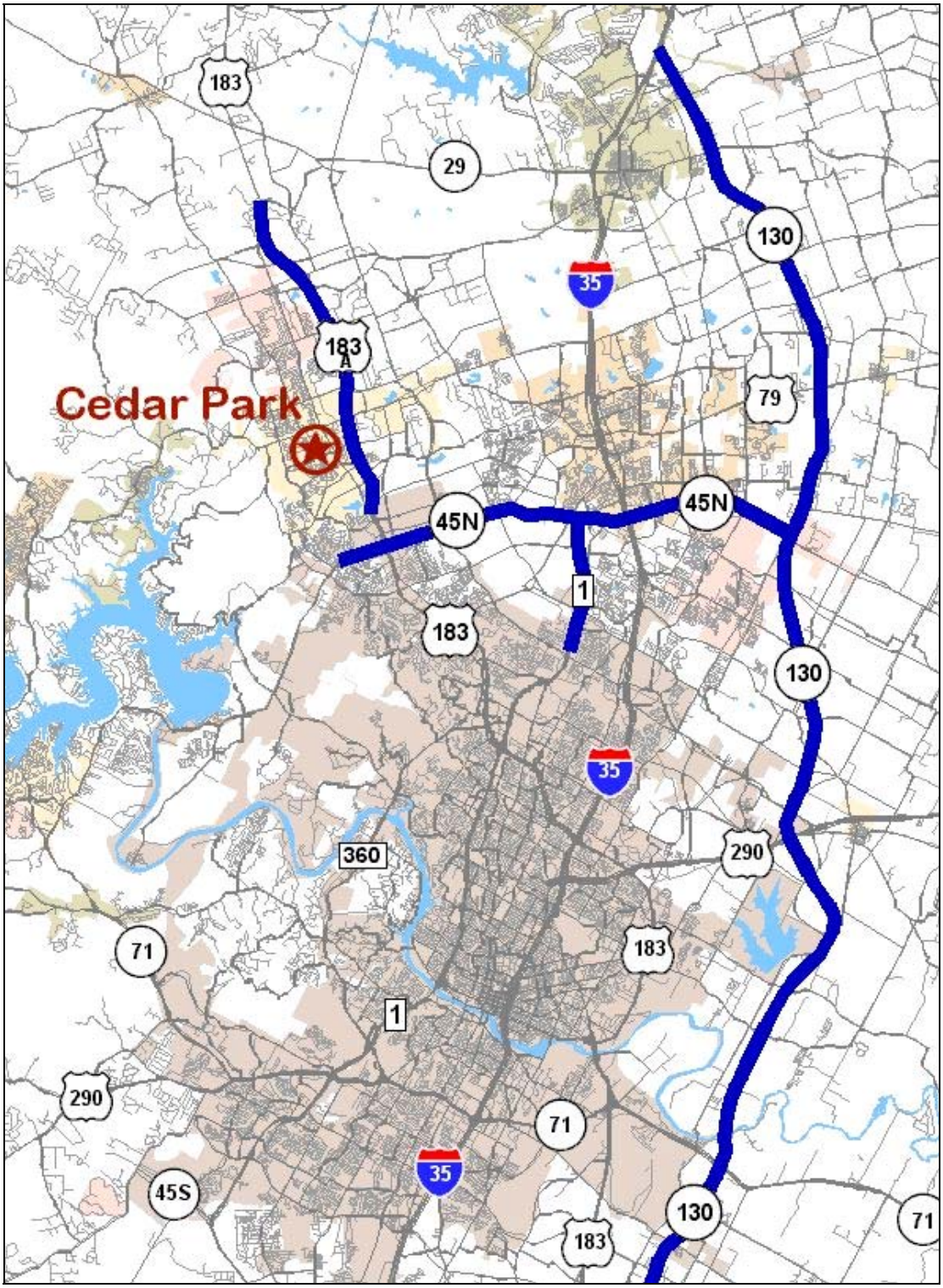
The construction of US 183-A is critically important to the future of Cedar Park's transportation system. US 183-A is one part of a regional system of toll roads planned for Central Texas. Three other planned toll facilities could affect Cedar Park's transportation system: State Highway 45 North, the Loop 1 North extension, and State Highway 130. While these proposed roadways will not directly tie into Cedar Park, they have the potential to divert traffic, especially freight traffic, away from the city. Figure 3.4 illustrates the proposed toll road facilities.

Cedar Park is developing its own internal transportation travel patterns as well. Providing additional east-west roadways of adequate capacity will encourage and support trips westward to recreational areas (hill country, nearby lakes), and eastward towards commercial and business centers in Central Texas.

In addition to the proposed toll facilities, Williamson County is seeking to extend Parmer Lane north beyond FM 1431 to connect it with IH 35. This extension would increase traffic volumes on Parmer Lane.

The Texas Department of Transportation (TxDOT) intends to widen Parmer Lane between FM 1431 and Loop 1, but these improvements will occur between 2017 and 2025. TxDOT is currently extending the freeway section of US 183 from Hunter's Chase Boulevard to RM 620. This improvement is expected to be complete in 2004.

## Figure 3.4: Proposed Central Texas Toll Facilities

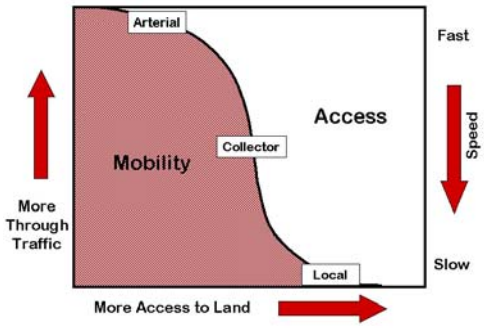


## *Functional Classification*

Functional classification is the process by which streets and highways are grouped into classes according to the character of service they are intended to provide. Individual roads and streets do not operate independent of each other, and the development of use of a hierarchy of roadway classes reflects this.

The need for access to destinations as well as the mobility to traverse long distances is a key element in the relationship of the functional classes. A local roadway is to provide access to a residence. An interregional freeway is to provide uninterrupted travel for extended distances. In between are the arterials and collector streets that provide intermediate levels of access. Figure 3.5 illustrates the relationship of mobility and access to the basic functional classes.

**Figure 3.5: Relationship of Mobility and Access to Roadway Classification**




## *Roadway Design Issues*

The overall functioning of a roadway is influenced by more than available capacity. Elements such as land use, maintenance, and access management play crucial roles. It is important that all aspects of a city's transportation system are given adequate consideration when reviewing roadway designs and locations.

There are many possibilities available during the design and configuration of future roadways. Fiscal limitations influence such elements as right of way acquisition, the number of lanes constructed, and even when and if certain roadway segments will be built. Many roads are built in phases. Where the current traffic demand does not warrant the construction of four lanes; two travel lanes will be constructed initially and two additional lanes will be built later. Similar limitations can postpone roadway improvements to add needed traffic capacity.

## *Implications for Roadway Design*

Local roadways can be designed to discourage through traffic. Local networks can have limited points of entry, curvilinear street designs and narrow roadway widths. Identifying the purpose of a roadway is the first step toward a successful design.

Additionally, traffic volumes and land use are two important elements of roadway classification and design. These elements are interrelated and can change over time. A

rural road could one day become an arterial providing critical access to a commercial development, drastically changing the daily traffic volumes.

The functional classification should represent both existing and future roadway conditions. This classification is made at the time of preliminary platting on new developments. Once designated, an official amendment to the Roadway Classification table is needed to change the classification. Further discussion of roadway classifications and their applications is included in Appendix D.

## *Recommendations*

With respect to specific roadways, alignments or developments, it is always advisable to review each proposed roadway as it impacts the entire network. Roads do not act in a "stand alone" manner and should not be designed as single elements. Special attention should be paid to the placement and spacing of collector roadways within new developments to help disperse traffic evenly. The Cedar Park City Council has previously passed and adopted several resolutions in support of increased connectivity within the city developments. Further developments should comply with the spirit and intention of prior City Council resolutions.

The following sections will discuss the suggested improvements to the City of Cedar Park roadway system. To assist in the construction and management of its roadways, the City of Cedar Park adopted the Austin Transportation Criteria Manual (TCM) to serve as the primary reference document for transportation infrastructure in the city. Where practical, it is preferable that the spacing, alignment and interconnectivity of the recommended roadways be consistent with recommendations in the Austin TCM.

### Current Roadways

The current network of arterial and collector streets in Cedar Park is loosely based upon north-south travel patterns. There is a need for increased east-west connections across the city, especially traversing US Highway 183. In addition, Cedar Park has several large scale commercial developments centered at the intersection of major roadways.

Residents are well aware of the difficulty progressing through the intersections of FM 620, US Highway 183 and smaller roadways. Geometric improvements to these intersections will help their operation. However, alternative routes to disperse traffic through the city are needed.

#### Future Arterials

The proposed network of arterial streets addresses in part the difficulty of traversing certain sections of Cedar Park. Several new proposed roads bisect large tracts of developing or undeveloped land.

In order to provide cross-town access, new arterials must be incorporated into new developments. Residential communities generate substantial amounts of daily traffic

and will require an appropriate number of access points. The proposed arterial roadway network map shows these roads as minor or major arterials. Figure 3.6 shows the Cedar Park Arterial Map adopted in April 2002.

The majority of proposed arterials do not have finalized alignments. Assuming that US Highway 183-A will be constructed within the designated right-of-way, connections to adjacent arterials will be made in accordance with the elevated toll road. In the event that the construction of 183-A is delayed, the proposed arterial network will be designed to serve the adjacent properties without compromising future connections to 183-A.

**Collector Streets**

Collector streets serve as the intermediary roadway between residential streets and higher volume arterials. It is often the case that streets with residential frontage, the on-street traffic volumes exceed the original design threshold(s). In these instances, collector streets can operate as minor arterials, regardless of their classification. Figure 3.7 shows the Cedar Park Collector Map adopted in April 2002.

## *Conclusions*

Where there are the opportunities, strong consideration should be made to designate future roadways, both arterial and collectors to facilitate internal accessibility and movement. For example, subdivisions with "stubbed out" streets should be encouraged by city officials to communicate with adjacent property owners to complete the connections.

In undeveloped sections of Cedar Park, city staff should place a strong emphasis on the creation of interconnecting roadways, including major and minor arterials. Several existing developments would benefit greatly from additional new (or completed) roads to arterials and commercial areas.

Following the adopted Roadway Maps is a Roadway Classification Table for the City of Cedar Park. In the table are all of the major and minor roadways within the City's jurisdiction, including their current and ultimate built out conditions. The table should be updated and modified on an annual basis. Please note that the final right-of way requirements and intersection geometries are subject to modification at the time of design. The table is provided as a planning tool only.

## *Resources*

The following list of resources provides several examples of municipal and regional transportation plans, including detailed discussions of roadway classifications, design standards, management practices and land development patterns. Most sources are available via the Internet. However, some copies can be provided in printed version

*2001 Regional Transportation Plan for the San Francisco Bay Area*
San Francisco Bay Area Metropolitan Transportation Commission
Oakland, California
http://www.mtc.ca.gov/projects/rtp/rtpindex.htm

*CATSO 2025 Transportation Plan*
Columbia Area Transportation Study Organization
Columbia, Missouri
http://www.ci.columbia.mo.us/dept/plan/catso.htm

*City of Richmond's Master Plan June 2000 (Draft)*
City of Richmond
Richmond, Virginia
http://www.ci.richmond.va.us/ecitizen/documents/index.htm

*Greater Bozeman Area Transportation Plan 2001*
City of Bozeman
Bozeman, Montana
http://www.bozeman.net/planning/TransPln/Intro.htm

*James City County Comprehensive Plan*
James City County Planning Division
James City County, Virginia
http://www.james-city.va.us/about/complan.html

*Travel Demand Model Activities Cedar Park – Capital Improvement Program Support*
City of Cedar Park 2001

# STREET DESIGN GUIDELINES

## *Roadway Design*

A city's roadway system influences public perception of the city. Individuals find poorly designed thoroughfares cumbersome. Roadway design affects the functioning of the transportation system as a whole.

A well-designed thoroughfare can provide lower travel times, increased safety and convenient access. Roadway design can also control vehicle speed and influence roadway noise levels. The physical design of the roads plays a role in the efficiency, economic viability, and quality of life.

## *Determinants of Design*

Many elements are considered in the physical design of a roadway. Issues such as the functional class of the roadway, surrounding land use, and physical terrain help determine the ultimate design.

The surrounding land use is the most influential in the design of the roadway. Land use affects the amount, type, and time of traffic on a particular roadway. For example, an elementary school generates traffic much differently than a commercial district.

Functional classification identifies the intended function of the roadway. Related to land use, the functional classification of a roadway is based on the amount and type of traffic it should carry. Logically, a roadway that services residential houses has a much different traffic load than a freeway and should be designed and constructed accordingly.

Pedestrians, bicyclists and transit users should be provided for as they make up an integral part of the transportation system. It is more cost effective to initially plan for these components rather than retrofit them into an existing roadway.

## *Right of Way Issues*

Right of way is the term used to describe the space within which the roadway and its supporting elements are built. The availability of right-of-way can be a determinant as well as a result of street design. Limited or poorly planned right-of-way can restrict the inclusion of necessary design elements.

When designing a transportation facility, all future users, including adjacent land use needs should be considered when allocating the final amount of right-of-way to be occupied. Retrofitting transportation elements into constrained corridors is a very costly proposition. Figure 4.1 illustrates the roadway elements that are considered part of the right-of-way.

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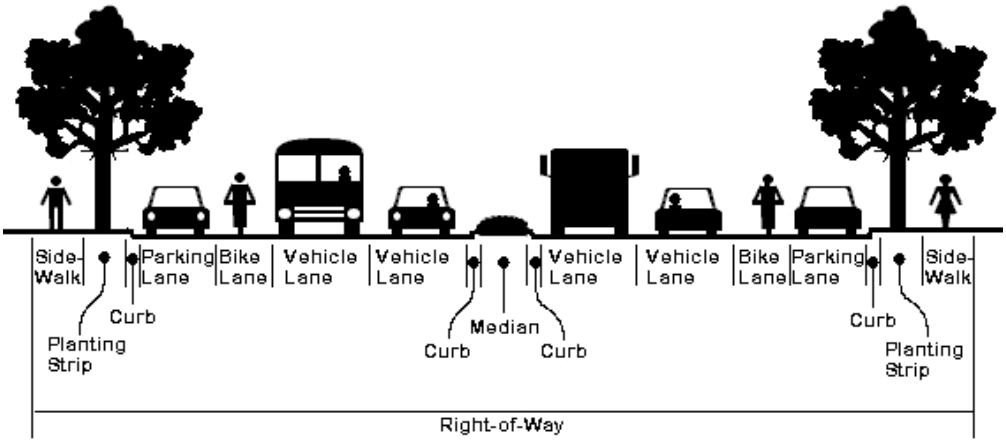
**Figure 4.1: Right-of-Way Elements**




The required right-of-way widths for individual elements vary according to functional classification and design specifications. Table 4.1 lists the recommended minimum and maximum widths acceptable for certain design elements.

**Table 4.1: Design Element Dimensions**

| Design Element | Minimum Width | Maximum Width |
|---|---|---|
| Sidewalk | 5 feet | 10 feet |
| Parking Lane | 7 feet | 8 feet |
| Bike Lane | 5 feet | 6 feet |
| Planting Strip | 3 feet | 7 feet |
| Centerline Median | 3 feet | 20 feet |

Source: Austin TCM, AASHTO Green Book

## *Aesthetics*

Aesthetic appeal is another aspect of roadway design. Properly placed landscape elements can beautify a roadway while offering some influence over roadway noise. If desired, landscaping treatments should be considered during the design phase of the roadway project, as retrofitting a roadway is often more expensive.

Table 4.2 provides a summary of the roadway components for each functional classification. Also listed in the table are guidelines regarding the use of particular elements within a given facility.

## Table 4.2: Functional Classification and Roadway Element Matrix

| | Roadway Component | | | | | |
|---|---|---|---|---|---|---|
| **Functional Classification** | **Medians** | **Sidewalks** | **Bikeways** | **Planting Strips** | **On-Street Parking** | **Traffic Calming** |
| Freeway | Required | N/A | N/A | N/A | Prohibited | N/A |
| Parkway | Required | N/A | N/A | N/A | Prohibited | N/A |
| Major Arterial | Considered | Required | Considered | Required | Prohibited | N/A |
| Minor Arterial | Considered | Required | Considered | Required | Prohibited | N/A |
| Primary Collector | Optional | Required | Considered | Required | Conditional | Allowed |
| Industrial Collector | Optional | Required | Discouraged | Required | Prohibited | Discouraged |
| Commercial Collector | Discouraged | Required | Considered | Required | Conditional | Allowed |
| Neighborhood Collector | Discouraged | Required | Considered | Required | Conditional | Allowed |
| Residential Collector | Discouraged | Required | Considered | Required | Conditional | Allowed |
| Local Street | N/A | Required | Optional | Required | Allowed | Allowed |
| Alley | N/A | N/A | Optional | N/A | Prohibited | N/A |

## *General Design Guidelines*

The Austin TCM provides specific standards and recommended designs for various physical infrastructure elements, such as roadway widths, sidewalks, setbacks, etc. The City of Cedar Park uses the TCM as the first reference for roadway standards and design guidelines.

Street design guidelines provide uniform construction standards for a road's roadway system. Standards and guidelines provide the basic design criteria for each functioning level of roadway of the transportation network.

Because the Austin TCM was created for a large city, its recommendations may not always be suitable for the City of Cedar Park, especially where smaller, local streets are concerned. Where this document and the TCM differ, thorough review and careful consideration should be given to selecting an appropriate design. Pursuant to accepted engineering standards and practices, alternate designs other than those presented in the Austin TCM may be considered.

The next section describes the elements and requirements pertaining to each functional classification. Selected detailed design cross-sections are presented in Appendix B. The design cross-sections address each of these elements with regard to a particular type of roadway. The final right-of-way widths are determined based upon the applications of the roadway. With respect to final intersection designs, attention should be paid to the ultimate build out requirements for the intersections. Specifically, additional right of ways needs for dedicated turning lanes and/or clear spaces for pedestrian access should be anticipated during the initial design phase.

The design guidelines found in this chapter are to be used as a working manual of best design practices for constructing, reconstructing, and improving Cedar Park's major street network. They are not to be used in lieu of engineering science and judgment.

Design guidelines in this chapter should be met except when an action or decision can be justified through consideration of the following:

1) Topography or slope constraints;
2) Significant trees or other vegetation;
3) Other natural resource constraints, including wetlands, wildlife habitat, etc.;
4) Historic landmarks and resources;
5) Insufficient right-of-way, and inability to obtain additional right-of-way;
6) Previously adopted City policies, including those found in neighborhood plans.

**Arterial Design Guidelines**

The typical design elements found within the right-of-way for arterial streets are: vehicle lanes, median islands, drainage gutters and curbs, planting strips, street lighting, sidewalks, and utilities. Optional features include bicycle lanes and (in some cases), on-street parking. All of these design elements are specified within a designated paving width

and right-of-way width for each particular street. Supplemental recommended cross section details of arterial roadway dimensions are provided in Appendix B of this document.

**Pavement Width Design Guidelines**

In general, pavement width designs should incorporate the following objectives:

- Total pavement width should balance constraints due to available right-of-way; anticipated travel modes: pedestrian, transit, and bicyclist needs; and the overall street function and traffic capacity needs.
- Pedestrian refuge medians and/or landscaped medians with pedestrian refuges should be designed into arterial and collector street intersections.
- Consideration of one-way street pairing instead of widening streets in built-up areas with right-of-way constrictions.
- Increasing right-of-way width to accommodate high-occupancy-vehicle (HOV) lanes, bicyclists, or oversize vehicles.
- Avoid placing utility access covers within bicycle lanes on new streets.
- Empower city staff to make an initial determination of required Right-of-Way and pavement widths for street construction.
- Utility placement and design of curbs and drainage facilities shall be in accordance with adopted TCM Street Design Standards

Table 4.3 Pavement Width Design Standards

| Classification | Minimum curb pavement width | Maximum curb pavement width | Total Right of Way |
|---|---|---|---|
| Major Arterials | 64 feet | 94 feet | 100 – 120 feet |
| Minor Arterials | 46 feet | 70 feet | 75 – 110 feet |
| Major Collectors | 32 feet | 44 feet | 60 – 85 feet |
| Neighborhood Collector* | 30 feet | 42 feet | 44 – 55 feet |
| Residential Streets | 30 feet | 32 feet | 46 – 60 feet |

*Pavement widths for Neighborhood Collector streets may vary depending on the availability of on-street parking, sidewalks and the need for bicycle lanes or for oversize vehicles.

**Travel Lane Widths Design Guidelines**

- Travel lane width is a minimum of 9 feet on local streets to a maximum width of 12 feet for major arterials. For wide outside curb lanes, 15-foot wide lanes may be used instead of striped 5-foot bicycle lanes. All inside lanes on multilane roads are to measure 12 feet as a maximum width.
- Major Arterials. Travel lanes should be 12' wide, except turn lanes.
- Minor Arterials. Travel lanes should be 11' wide at a minimum, 12’ wide for commercial streets.
- Major Collectors. Travel lane widths should be 11' wide, although wider lane widths may be required for industrial areas with truck traffic.
- Neighborhood Collectors. Travel lane widths on Neighborhood Collector streets should measure between 10' and 15', depending upon use of the lane for bicycles.

Table 4.3 Typical Travel Lane Widths

| Classification | Min. Width | Max. Width |
|---|---|---|
| Freeways | 11 feet | 12 feet |
| Major Arterials | 10 feet | 12 feet |
| Minor Arterials | 10 feet | 12 feet* |
| Major Collectors | 10 feet | 12 feet* |
| Collectors | 10 feet | 11 feet* |
| Local Streets | 9 feet | 10 feet |
| Alleys | 8 feet | 12 feet* |

*Except for outside lanes shared with bicycles

**Sidewalks Design Guidelines**

Sidewalks and other pedestrian improvements are vital to the function of arterial and collector streets designed for multi-modal use. Sidewalks provide critical access to all properties: commercial, residential, industrial and public. Sidewalks and other pedestrian improvements are essential components of all new street projects as well as major reconstruction projects.

Setback sidewalks on both sides of the street are the preferred pedestrian design choice for arterial and collector streets. To promote pedestrian use and access to key destinations, sidewalks should be continuous along all arterial and collector streets. Gaps and substandard elements in the pedestrian system should be closed or rehabilitated where necessary.

Sidewalks should be designed with adequate width to accommodate all existing or anticipated uses, including loading and unloading of people from on-street parking, walking traffic, window shopping traffic, bicycle parking, and use of street furniture. All sidewalk designs and access points must comply with the federal requirements set forth in the 1990 Americans with Disabilities Act (ADA), as well as subsequent legislation (ISTEA, TEA-21, etc.).

**Sidewalk Design Standards**

- A suggested minimum buffer zone width of 4 feet for sidewalks of minimum width of 5 feet except for the following situations:
- Alternating setback and curbside or meandering sidewalks shall be permitted in areas where constraints and right-of-way limitations exist.
- Sidewalks in commercial areas shall be designed to provide adequate space for pedestrian travel, street furniture, and related uses.
- Sidewalks in pedestrian-oriented commercial areas should be a minimum of 10 feet wide, and shall incorporate tree wells in lieu of landscaped planter strips.
- Sidewalks shall not have obstructions (such as mailboxes, signs or utility boxes) that reduce the usable clear travel width of the sidewalk below 5'.
- Sidewalks shall be continuous along the full frontage of a commercial development.
- All driveway entrances and other curb cuts shall be constructed flush with the adjacent street surface.

**Curb & Gutter Design Guidelines**

Curb inlets are the preferred design option for storm water facilities. Where installation of curb inlets is not possible, catch basins with approved bike-proof covers is an acceptable alternative. Bicycle lanes shall not include access ports such as drainage grates and utility covers within the 5-foot minimum travel width. Further discussion of recommended bicycle lane elements is included in *Chapter 5: Bikeways.*

**On-Street Parking Design Guidelines**

Appropriate levels of on-street parking support increased economic activity by increasing the visibility of storefronts and signage to motorists parking on the street. Properly designed parking also provides space for passenger and freight loading and unloading in commercially developed areas. In residential neighborhoods, marked space for visitor parking can provide narrowed travel lanes and reduced overall width on streets.

Parallel parking is the preferred parking layout for on street parking. On-street parking can decrease the capacity of the adjacent travel lanes from 3% and 30% depending on the number of lanes. It is important to balance the demand for through movements with local access requirements when deciding where to provide on-street parking. As a general rule, parking lanes should be marked at 7 feet on low volume streets to encourage motorists to park closer to the curb. A maximum width of 8 feet is recommended for an on—street parallel parking lane.

On-street diagonal parking can be considered as an option in certain circumstances and on a case-by- case basis. Optimal circumstances for provision of diagonal parking include adequate overall street width and low volume, low speed vehicular traffic. Parking lanes on

arterial streets need to be wider than other lower volume streets to provide a margin of safety between parked cars and adjacent travel lanes. To avoid expensive retrofits, provide for on-street parking based on the planned, rather than the existing, land use pattern and densities.

**Raised Medians Design Guidelines**

Arterial and collector streets may have a raised median area to decrease the potential for accidents, restrict turning movements, limit land access, and provide a refuge area for pedestrians or turning vehicles. Medians can be used as part of an overall corridor access management strategy to reduce vehicle conflicts, increase capacity, and reduce accidents at intersections.

It is important to provide for maneuvering room at downstream intersections or median breaks when medians are used for access management. Medians that function to limit turns, limit land access, or reduce mid-block accidents can be relatively narrow and still provide the necessary channelization. Major intersections, such as two intersecting arterials, may require the installation of medians for a determined distance in order to address issues of safety and operational efficiency. Medians at critical intersections can have a specialized dropped, low curb to ensure adequate access for emergency services equipment and personnel.

Landscaped medians are used to provide an aesthetic separation between travel lanes and must provide adequate room for tree root growth. The width of landscape medians is variable, depending on the varieties of trees and shrubs planted in the median. Prior to the construction of extensively landscaped medians, the maintenance and upkeep of the shrubbery should be determined.

**Adjacent Land Use Design Guidelines**

Site planning and design of buildings adjacent to arterial and collector streets can significantly contribute to walking, bicycling, and other means of access besides the private vehicle. Site and building design is an opportunity to redirect private investment to support multi-modal transportation and environmentally friendly transportation methods. Buildings should face the street in all densely developed areas within the city. Orienting the front entrance of buildings to the street is fundamental to increasing regional and local accessibility. It also facilitates pedestrian access and supports pedestrian activity on the street.

Discourage residential fencing along arterial and collector streets that isolates the development from the street. Encourage residential building orientation to the street by providing for on street parking wherever possible, and by encouraging on-site parking access via alleys. Consolidate multiple driveways on arterial streets into single access points.

To minimize the visual and circulation impacts of uninterrupted stretches of privacy fencing,

access points for bikeways and sidewalks should be spaced every 600 to 1000 feet.

**Streetscape Design Guidelines**

The streetscape is defined as the built and planted elements of a street that help to create an identity. To create a sense of identity, encourage the provision of continuous streetscape features. Provide street lighting on arterial and collector streets to enhance safety for all modes of travel. Where appropriate, provide pedestrian-scale lighting to provide a visual separation from vehicular traffic. Pedestrian-scale streetlights are lower than conventional streetlights and spaced more closely. Special light standards and detailing may be used to distinguish certain districts.

To encourage more pedestrian use of the streetscape, kiosks, benches, newspaper racks, trash cans, outdoor cafes, etc. can be used to increase the number of opportunities for people to socialize and spend leisure time outdoors. "Stationary" pedestrian activities such as standing or sitting are an opportunity for people to observe or participate in public outdoor activities. Seating can be either primary (chairs and benches, such as those found at a cafe), or secondary (low walls, steps, or fountain edges), where people spontaneously collect.

**Aesthetic Design Guidelines**

The aesthetic appearance of a roadway is often a neglected element of the design process. General elements already included in the design of most streets could be designed in a manner that would add to the attractiveness of the roadway. Meandering sidewalks, landscaped medians, and variable surface materials are items that can provide a more appealing design appearance.

Many elements can be added to the right-of-way, which improve the appeal of the roadway, even after construction. Items such as street lighting, plantings, and what is called "street furniture" can all add appeal to a roadway in a non-invasive manner.

Plantings can serve to shield cars from on-coming headlights and serve as a noise barrier to nearby houses. A detached sidewalk with adequate street lighting and benches is much more inviting to the pedestrian than its alternative. This can also increase pedestrian safety. It is important to develop guidelines regarding the placement of visual elements to insure against the obstruction of driver sightlines and visibility, both when first planted and after several seasons' growth.

## *Issues to Consider*

The proposed street classifications represent both the existing and anticipated future function of each street. The current pattern of major and minor street usage has evolved over time. Very little of the transportation system has been master-planned. The proposed classifications are based on a combination of historical, present, and future

travel patterns. Travel in the region 20 years from now will occur on the same major streets that are on the ground today.

Traffic volume is one of five criteria that have been used in the determination of each street's classification. For purposes of the current recommendations, current (i.e. within the past two to four years) traffic volumes were used. In cases where a street does not yet exist, or where it is partially constructed or the adjacent area is mostly undeveloped, an assessment was made of future volume in order to compare the street with other streets of similar function. Another criterion used in the recommended classification is the usage by and provision for alternative modes on each street segment.

This has the effect of influencing the determination of classification by looking at the intended or expected use of the street. The length and spacing criteria are generally based on existing conditions; however, where street extensions or new streets are planned, these future conditions should be taken into account.

The street classifications and design standards proposed in this document are intended to apply to Cedar Park's street network into the future. The review and adoption process for this document should be used to reach agreement on the function of specific street segments throughout the city.

Should street segments be identified for improvements in the future, the design guidelines in this document would assist that improvement. In the interest of consistency and effectiveness, a street's functional classification should not change in the absence of a change in policy or without evidence that the existing classification is inappropriate.

The Cedar Park code provides for adoption and amendments of the Street Classification Map and specifies that map amendments "shall be by ordinance." This provision would mandate a level of citizen involvement in future discussions about street classifications and design consistent with adoption of any new ordinance.

The classification of a street provides a basic indication of how that street functions as part of the overall street network. Since streets of like classification often have very different characteristics in terms of overall width, number of lanes, adjacent land use, and other key features, the classification itself only provides a starting point for the design. The design is influenced by a number of factors as discussed previously in this document.

Citizens are frequently concerned about potential changes that might occur on the street they live on, or use. There are a number of ways and practices that affect whether and how a given street might undergo a change of classification, alignment or purpose. The types of changes in a road's

functional identity range from regulation of access, to various sorts of improvements, to major capacity improvements. There is a strong relationship between the street's classification and these decisions, but many factors are important in determining the outcome for each situation.

**Adding Sidewalks**

On streets that have curbs and gutters, but lack sidewalks, the city should develop a policy to prioritize segments of streets for sidewalk retrofit. Generally the major and minor arterials are the highest ranking sections because of the safety implications of pedestrians trying to walk along these streets without continuous sidewalks. In some cases, though, a collector street or even a local street can be ranked higher based on key factors such as a nearby school or shopping area. For newly constructed roadways, the Austin TCM serves as the primary resource regarding the placement and alignment of sidewalks in Cedar Park.

**Adding Bicycle Lanes**

The higher priority is placed on adding bicycle lanes to arterials because of the need to provide a safe means of bicycling on these streets. Bicycle lanes are only infrequently provided on neighborhood collectors, and almost never on local streets. Occasionally, particular conditions on a neighborhood collector or local street might call for striping bicycle lanes, for example to designate suggested bicycle travel routes to schools, parks or other recreational areas.

**Upgrading Streets to Urban Standards**

In practice, the highest priority is placed on retrofitting arterials and major collectors to urban standards, for reasons of safety and provision of facilities for alternative modes of travel. Neighborhood collectors generally have a lower priority for upgrading, although each street should be evaluated on a case-by-case basis.

New streets are required to be built to current standards. Existing local streets are normally improved only when the property owners submit a petition indicating a desire for the improvement. The priorities for upgrading existing collectors and arterials to urban standards should be set by the City Planning Department.

## *Resources*

A Policy on Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials, copyright 2001

City of Austin Transportation Criteria Manual, City of Austin, Department of Public Works and Transportation, copyright March 1996

Roadway Design Manual, City of Eugene, Oregon copyright July 1999

Highway Capacity Manual, Special Report 209, Transportation Research Board, copyright 1998.

Texas Manual on Uniform Traffic Control Devices for Streets and Highways, Texas Department of Transportation, copyright 1994.

Transportation Engineering, Planning and Design, Wright and Ashford, copyright 1989.

# BIKEWAYS

## *Introduction*

The City of Cedar Park identifies bicycling as an alternative mode of transportation for its citizens. To this end, the comprehensive transportation plan includes this chapter to serve as a primer for the discussion of bicycling issues.

## *Goals and Objectives*

The City of Cedar Park has the following goals and objectives with regard to bicycle facilities. It is the interest of the City of Cedar Park:

- to promote and encourage bicycling as a reasonable means of access to schools, parks and other areas of interest or recreation
- to provide for safe and reasonable forms of exercise
- to provide a viable alternative to automobile use

## *Limitations*

This Bikeways chapter does not provide specific street designs, or layouts. It is offered to help guide the discussion of bicycling and bicycle facilities as a viable transportation option in Cedar Park.

In order to develop specific routes or bicycle facilities, a systemic study of the available roadways and objectives should be undertaken, following the recommendations outlined in this chapter. Included in the recommendations section of this chapter is a 'checklist' of actions that may prove useful in the identification and development of bicycling facilities.

## *Background*

The City of Cedar Park typifies the modern "bedroom community" with large suburban residential developments. Each development has its own connections to the high volume roadway network.

Bicyclists in Cedar Park face obstacles typically found in new suburban developments. The residential streets are wide, encouraging high speeds. The development patterns divide land uses between exclusively residential, commercial, recreational or industrial. Often higher volume roadways connect these land uses. The daily travel patterns of work or school related commutes, late evening shopping trips and multiple trips for individual or community recreation encourage the use of multi-passenger, high speed vehicles.

The result of the development patterns discourages non-automotive means of transport. Bicycle facilities can either be proactively incorporated into land development patterns, or retrofitted to existing designs. All proposed bicycle oriented facilities and improvements should be done in a clear, systemic manner.

Linking schools, community centers, recreational facilities and residential

subdivisions with well-marked and accessible bikeways will enable the citizens of Cedar Park to access key destinations by bicycle.

## *Typical Bicycle Planning Aspects*

Bikeway planning is often done separate from other planning efforts. This process can lead to non-integration of the bikeway proposals with other transportation elements. In the interest of minimizing conflict and confusion, consider bikeways within the larger transportation network.

## *Key Definitions*

The following terms and definitions will be used to describe various types of bicycle facilities. The terms outlined below will serve as the basis for the Bikeway Chapter discussions and recommendations.

**Bikeways**

Roadways must be designed to allow bicyclists to ride in a manner consistent with the vehicle code. "Bikeway" is the term used to describe any facility for use by bicycles, tricycles or a variable design. The term is for general descriptions, or recommended routes. It does not imply a specific dimension, design or orientation, other than to distinguish the path in question from one that specifically prohibits the use of bicycles (such as a sidewalk). In practice, nearly every street surface can be considered a bikeway. However, it is common for governing agencies to mark bikeways, either with stripes or signage.

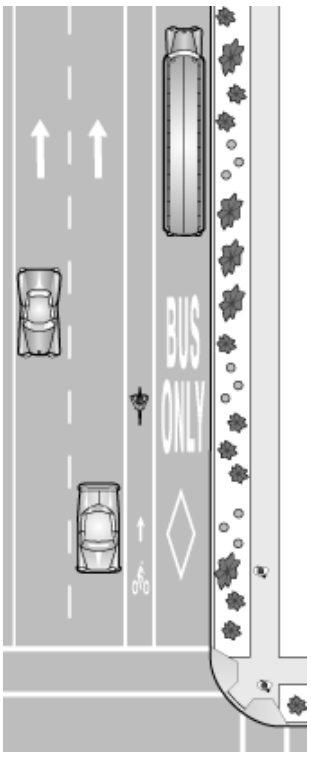
**Type I – Grade Separated Facilities**

Type I, or grade-separated bicycle facilities are smooth, marked paths used primarily for recreational purposes. A popular design feature is the 'double wide' recreational trail. Such trails make for attractive, scenic paths, usually well removed from traffic and urban areas. It is expensive, and often impractical to create grade-separated facilities for commuter bicycle access.


Bike paths are separate from the roadway

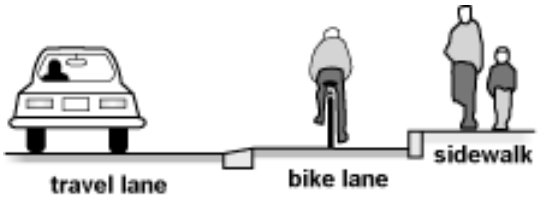
**Type II – Marked Shared Facilities**

The most common form of a Type II bicycle facility is the "bicycle lane" – a five-foot wide striped section of roadway with stencils and signage designating it for bicycle use. The bicycle lane is useful in designating a specific route and location for bicycle traffic. The designation of bicycle lanes along commuter routes may help to raise the awareness of bicycling in the minds of drivers.




Bike lane outside transit lane

Bike lanes are appropriate on urban arterials and major collectors. They may be appropriate in rural areas where bicycle travel and demand is substantial. Bike lanes must always be well marked to call driver attention to their use by bicyclists.




Elevated bicycle lanes on street surface

If demand for on-street parking is great, and travel patterns predictable, shared access to the bicycle/parking lanes can be managed by means of time restrictions on parking. Many urban areas allow overnight parking in bicycle lanes, but prohibit (and aggressively enforce) parking during daylight hours.

Bicycle lanes are outside parking lane

**Type III – Unmarked Facilities**

It is not necessary to designate all segments of a route for bicyclists. Roadways with low traffic volumes or narrow travel lanes may be difficult to stripe with lane lines. In this instance, access is taken at the judgment of the rider. It is sufficient to provide only directional markings at intersections (route or destination signs).

The advantage of unmarked facilities is that bicycles may use whichever section of roadway is needed for their maneuvers; much in the same way cars use the roadway. Bicycles are usually ridden on the right side of the lane, until turning or passing maneuvers are necessary, at which time the cyclist signals and performs the action.

Shared Roadway — On a shared roadway, bicyclists and motorists share the travel lanes. Unless the lane is wide enough, a motorist should cross over into the next travel lane to pass a bicyclist. Shared roadways are common on neighborhood streets and on rural roads.

Wide Outside Lane — Where shoulder bikeways or bike lanes are warranted but cannot be provided due to severe physical constraints, a wide outside lane may be provided to accommodate bicycle travel. A wide lane (14+ feet) usually allows an average size motor vehicle to pass a bicyclist without crossing over into the adjacent lane.

An unmarked shared roadway

Cyclists using a wide outside curb lane

Shoulder Bikeway — Paved roadway shoulders on rural highways provide a suitable area for bicycling. They have few conflicts with faster moving motor vehicle traffic. Most rural bicycle travel on the state highway system is accommodated on shoulder bikeways.

Wide shoulders for bicyclists

**Recreational & Mixed Use Trails**

These facilities are open to bicyclists, joggers and walkers, usually in close connection to a larger recreational facility, such as a park, or athletic field. The anticipated volume of bicycles on these facilities is low; otherwise congestion may become an issue. One solution regarding access management to mixed-use trails is to institute a standard protocol for the facility. Either inform pedestrians to yield to bicycles, or vice versa, as well as instructional signs informing users of how to announce the intention to pass.

Recreational trails along scenic routes

**Exclusive use facilities**

Control of access can also play an important role in the development of bikeways. The designation of residential streets for exclusive use by bicycles can be used to channel bicycle traffic along particular streets.

The term "bicycle boulevard" refers to an operational modification of a local street to function as a through street for bicycles while allowing only local access for automobiles. Traffic controls limit conflicts between automobiles and bicycles and give priority to through bicycle movement. This reservation of surface roads for use by bicycles is particularly useful when seeking to encourage a large number of bicyclists.


Exclusive through access for bicycles

## *Design of Bicycle Facilities*

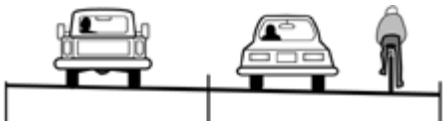
Bicycle facilities should be designed and built according to an established set of engineering guidelines and standards. Several texts provide recommended dimensions and markings for bike paths, lanes and intersections. The principal references used for this section are listed in the back of this chapter.

The dimensions of all facilities should remain as consistent as possible. The design of facilities should match their intended uses. Broken or discontinued routes are strongly discouraged.

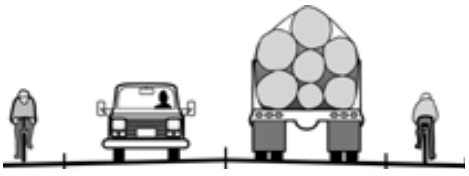
**Design Minimum Widths**

Wherever possible, a minimum width of clear roadway surface should be provided for bicyclists. Failure to do so obligates cyclists to compete with motor vehicles, placing the bicyclist at greater risk.

Bicycle facilities should provide a minimum of 5 feet clear width for travel per direction. In the case of bi-directional paths (such as recreational trails), a clear space of 12 feet is recommended. In the case of roadside facilities, such as marked bike lanes, the width of the gutter pan can be used to determine the 5 feet clear width. Included in Appendix B are supplemental cross sections providing additional illustration of bike lane and off road trail dimensions.



Wide curb outside lane



Paved shoulder bicycle lane

**Marking and Signage**

When marking bicycle facilities, care should be made to direct instruction to both drivers and cyclists. Signs and markings for bicyclists should be done in a manner that provides adequate warning of changes in route, ending of marked facilities, or critical elements (for example access to an over or underpass).


Typical roadside signage

## *Definition of Bicycling Styles*

Similar to differing types of bicycles, there are several ways to classify types and populations of bicyclists. The following definitions will be useful in determining the appropriate facility.

**Recreational/Tourist**

Most bicycle facilities are designed for recreational use. The markings and signage are provided for ease of use and scenic routes. Recreational bicycling is expected to provide intermediate and beginning bicyclists an opportunity to use designated routes without the constraints of travel times, congestion, and multiple intersection crossings. The prototypical recreational bicycling trail is the grade separated greenbelt system, with long stretches of uninterrupted paths.

**Commuter**

Similar to driving, commuting on bicycles is characterized by a need for safe, efficient and time sensitive travel routes between destinations. The routes need not be marked frequently, nor even striped for bicycles, as the use of the roadway is very similar to that of a motorized vehicle. Dependent upon the cyclist, the commuter route may be a combination of major and minor roadways, usually providing the most practical travel routes.

**Touring**

For the purposes of this discussion, “touring” bicycling is separated from recreational in terms of location and overall length. While it is reasonable to assume that recreational trails will appeal to serious bicyclists, the

development of bicycle oriented routes for long distance rides, with adequate facilities, will serve the bicycling population on a regional level.

**Youth**

Youth bicycling will be the term used to describe novice riders unfamiliar with vehicles on the roadway. It is assumed that a youth or child rider will be less likely to travel long distances, unmarked routes, or along high volume roadways. Additional provision for groups of youth riders may be an issue for recreational areas such as public parks, open fields, green spaces or school campuses.

## *Applications of Bikeways*

Bicycle facilities can be built in several forms:

- exclusively for recreational use
- integrated into the roadway network
- as commuter pathways

Each of the above applications has merits and drawbacks. The categories are not mutually exclusive and are more reflective of management philosophies than clearly defined facility designs.

For example, the use of exclusive bicycle only paths can play a large role in the development of a recreational trails system. However, they are expensive to construct, and will have little impact upon daily trips within a region. In contrast, a more cost effective approach to shifting the modal split in favor of non-automotive trips would be to mark major streets with bicycle friendly elements and encourage the installation of bicycle parking stations at key destinations.

**Recreational Trails**

Exclusive recreational trails are established to provide safe, accessible and attractive pathways. Typically, the trails and paths are asphalt pavement or crushed gravel, with well placed signs detailing direction, distance and points of interest. Critical to the successful implementation of a recreational trails system is the distinction between users: whether the trails are to serve walkers and joggers as well or exclusively bicyclists.

Recreational trails are expensive to construct but can become valuable resources for parks and open public spaces. Some municipalities have developed an accessible and friendly trails and

open green space program to help define the identity of a city.

In an area without a firm image for bicycling friendliness, creating an exclusive use trails system may not be the best means of introducing bicycle facilities.

**Integrated Roadway Networks**

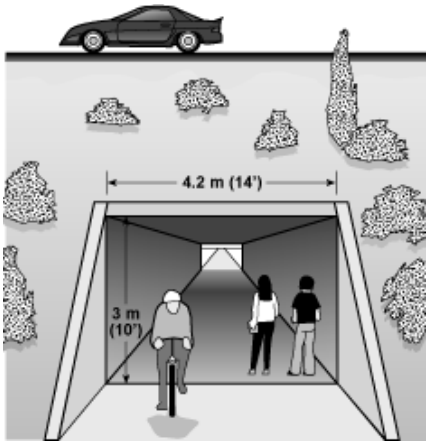
Integrating bicycle facilities into roadway designs can encourage the use of existing network for bicycle travel. Integration between modes does not require expensive or extensive construction as the objective is more to encourage the change of travel mode, not necessarily travel route, purpose or time period.

Designing bicycle routes and connecting roadways by signage and strategic striping of lane assignments can encourage short distance trips. Longer distance trips can be encouraged with the publication of maps, scenic routes, and the encouragement of end of trip facilities at key destinations, such as public showers, lockers, and secure or sheltered bicycle parking.


**Access to Critical Destinations**

To function within an existing transportation network, bicycle facilities should be designed to provide the most direct and safest connection between established destinations.

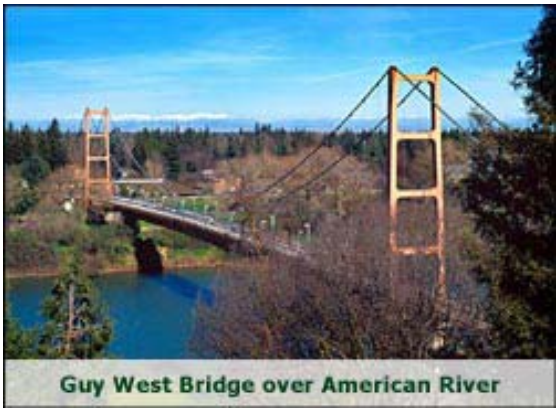
For example, rather than requiring cyclists to travel through a surface roadway network of signalized intersections, bicycle friendly (and car inaccessible) alleyways and bridges can be used to provide improved access. Surface streets that previously ended in cul-de-sacs can be interconnected with curb cut ramps and paved (or gravel lined) paths. Freeways that create barriers for pedestrians and bicyclists can be crossed using well-designed and placed underpasses.




A combined use underpass

Natural boundaries (such as bodies of water), can be traversed by specialized structures, which will also serve to channel the non-automotive traffic.

The following photo shows a suspension bridge connecting a residential area with the adjacent state university. The majority of the residents in the apartment complexes are students, thereby creating a de facto extension of the campus housing facilities.



Guy West Bridge over American River

## *Educational Programs*

It is necessary to include education of the general public with regard to bicycle facilities, rules of the road, safe storage practices and infrastructure improvements. Several programs exist to instruct beginning riders, parents, police officers, and any other identifiable population with respect to bicycle facilities. A list of bicycle advocacy organizations is provided at the end of this chapter.

**Bicycle Riding Skills**

As discussed earlier, there are many different rider types. Classifying various riders as youth, commuter, recreational, etc., will serve the management interests of overseeing agencies. However, for the riders themselves, such titles may be limiting or meaningless. It may prove more useful to offer forums in which different audiences can be shown a structured presentation. Schools, libraries, large offices and similar gatherings can be used to disseminate information about critical aspects of cycling. Significant praise and positive comments have been directed towards the confidence building and safer riding behavior resulting from such instructional seminars.

**Bicycle Friendly Facilities**

In addition to encouraging a uniform level of bicycle riding practices, bicycle friendly facilities play a valuable role within the transportation network. Property owners and managers, as well as school administrators, and security personnel should be informed about the need for adequate space, lighting, shelter, and changing rooms.

**Encouraging Bicycling**

Free or discounted distribution of bicycle maps, ride-to-work or ride-to-school events, and clean-air days can all be used to publicize and encourage more bicycle use.

More formal programs, such as transit passes, subsidized parking fees or discounts for not driving to work, and rideshare programs, etc., have been successfully

implemented in other cities. However, a critical mass of cyclists or at least a willing 'champion' is necessary to sustain and develop such programs. In the case of a limited bicycling demand, more effective efforts can be directed towards the development of accessible facilities.

**Bicycle Maps**

Bicycle maps enable users to access the facilities for a given activity or region. A standard system of symbols and colors will help future additions and revisions to the map.

There are four basic types of bicycle maps: urban bicycle maps, regional bicycling guides, recreational/touring maps and city planning maps.

The first three types are used by bicycle riders; the fourth can be used by a wide variety of parties.

**Urban Bicycle Maps:**

This type of map is used by local bicyclists, newcomers and visitors to choose routes they feel comfortable cycling on, and to encourage making trips by bicycle.

All serviceable streets should be shown. A simple color code indicates the presence and type of bicycle facilities. The map should warn bicyclists of roads they should use with caution. The accompanying text should provide information on the proper use of bikeways, traffic laws and safety tips.

Some bike maps mention other useful information such as steep hills, weather data, parking facilities, bike shops, important destinations and other landmarks of interest.

**Regional Maps:**

This map is for recreational and touring riders interested in long-distance trips or trips along a specific scenic route. Particular concerns when choosing a route are traffic volumes and roadway conditions. Traffic volumes can be indicated using color-coded lines.

The map should include state highways and county roads. The level of detail needed is less than on an urban map. Other information to include is distances, grades, weather data, (especially prevailing wind directions) and camping facilities. Supplemental text can be used for information on local history, landmarks, scenic overlooks, etc.

Since bicycle trips often cross jurisdictional boundaries, counties are encouraged to coordinate regional maps, covering a natural geographical area within easy reach of several population centers.

**Recreational and Touring Maps:**

This map is intended for low skill level bicyclists on tourist or recreational tours. The format can be foldout maps, strip maps or brochures. Various agencies can cooperate to produce and distribute maps, especially for tourist attractions and commercial districts. If a loop or one-way tour is best when cycled in

one direction only, this should be emphasized in the text.

Points of interest are important, as are distances, grades, availability of water and rest areas. A written description of the route listing landmarks and turns is useful.

**City and County Planning Maps:**
These maps are intended for planners, advisory committees, designers, engineers, elected officials and interested citizens. The maps show planned and existing facilities. They should be readily available to the public upon request.

Use a simple code, like the following: open and closed geometric shapes with solid lines for existing routes. Dashed lines can be filled in when projects are completed. Black and white designs make these maps easy to photocopy, enlarge and send by fax machine.

**Additional Comments:**
Good maps are clear and simple. Too many symbols and details create confusion. Only necessary information should be included:

For urban maps, all city streets should be shown, as well as schools, public agencies and other common destinations. Not every street needs to be coded for bicycling purposes: most residential streets and minor collectors function well as shared roadways and should be left open on the map.

For bicycling guides, too much topographical detail obscures the information that is really useful. Seek to present relevant information in a manner that does not clutter.

For touring guides, inclusion of all roadways in the vicinity creates a confusing, web-like effect. Only the roads on the tour need to be included, along with roads that connect the route to other localities. Insets of urban areas are useful. It is usually better to create an additional map, rather than expand an existing one.

Other important considerations are:

- Symbols and text should be oriented in a consistent direction.
- Descriptive text should be placed as close as possible to the relevant map segment.

## *Facilities Management*

Similar to the system of surface streets and interconnecting infrastructure, bikeways require constant management to preserve their utility, safety and accessibility.

In addition to surface conditions such as roadway striping, signage, and sweeping schedules, the maintenance of bicycle facilities can extend to security lighting of over or underpasses, grooming of recreational trails, installation and upkeep of parking stands and possibly shower or changing areas.

**Management Basics**

Bicyclists ride on two narrow, high-pressure tires. What may be an adequate roadway surface for automobiles (with four wide, low-pressure tires) can be treacherous for cyclists. Small rocks, branches and other debris can deflect a wheel. Minor ridges in the pavement can cause spills, and potholes can cause wheel rims to bend. Wet leaves are slippery and can cause a fall. Gravel blown to the side by traffic accumulates in the area where bicyclists ride. Broken glass can easily puncture bicycle tires.

Bikeways require maintenance to function well. Poorly maintained facilities become unusable and a legal liability, as cyclists who use them may risk equipment damage and injury. Others will choose not to use the facilities at all.

Road users are often the first to experience deficiencies. Spot-improvement programs enable bicyclists and pedestrians to bring problems to the attention of authorities in a quick and efficient manner. Postage-paid, pre-addressed postcards can be made available to the public, to be sent in when they notice a needed improvement. Telephone numbers for staff contacts are included. Quick response from the city improves communications between the public and staff.

**Striping and Signage**

All striped lanes and lane markings should be standard width white paint (4”) and clearly visible to motorists. The layout of signs and markings should be consistent and conform to the Texas Manual of Uniform Traffic Control Devices (MUTCD).

Some municipalities have opted to use raised pavement markers (RPM) to help discourage driving in the marked bicycle lanes. RPM’s can be problematic for bicyclists. Per the MUTCD, "raised markers generally should not supplement right edge lines", therefore it is suggested that existing RPM’s be removed if not needed for motorist safety. Any RPM’s deemed necessary should be installed on the motorists' side of the stripe.

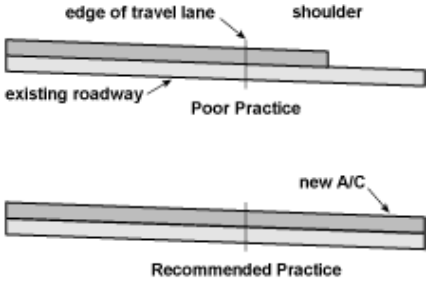
**Street Sweeping**

Bicyclists avoid shoulders and bike lanes filled with gravel and other debris; they will ride in the roadway instead. Debris from the sidewalk should not be swept onto the roadway.

A regularly scheduled inspection and maintenance program helps ensure that travel way litter is picked up or swept. If possible, seek to prevent the problem by encouraging the use of tarps over gravel trucks, or requiring immediate clean up of broken glass and other hazards at car crash sites.

**Street Repairs and Overlays**

Pavement overlays are good opportunities to improve conditions for cyclists if done carefully: a ridge should not be left in the area where cyclists ride. This can occur where an overlay extends part-way into a shoulder bikeway or bike lane. Overlay projects also offer opportunities to widen the roadway, or to stripe the roadway with bike lanes.




Overlays should cover the entire roadway

After overlays, raise inlet grates, manhole and valve covers to within 6 mm (1/4") of the pavement surface. Pave gravel driveways and approaches 4.5 m (15 ft) from the edge of pavement to prevent gravel from spilling onto shoulders or bike lanes.

**Security Lighting and Patrols**

Dependent upon the type and location of bicycle facilities, scheduled service inspections for lighting and security patrols may be necessary. For freeway underpasses, well-spaced light fixtures and adequate drainage will help to keep the facility attractive and secure. Rural trails or paths removed from populated areas should have security phones with well-maintained lights.

**Recreational Trails**

Vegetation encroaching into bikeways or walkways is both a nuisance and a problem. Roots should be controlled to prevent break-up of the trail surface. Adequate clearances and sight-distances should be maintained at intersections, especially for mixed-use trails. Signs advising bicyclists of pedestrians, vehicle access points, or other hazards should be clearly visible. For areas subject to water runoff, a maintenance program for erosion should be developed.

Local ordinances should allow road authorities to control vegetation that originates from private property. Some jurisdictions require adjacent landowners to control vegetation, or else maintenance personnel perform the work and bill the property owner.

**Bicycle Parking and Storage Areas**

Where high volumes of bicyclists are anticipated (or encouraged), such as at schools, public buildings, or recreational areas, resources need to be committed to the installation, maintenance and supervision of bicycle parking areas. If racks become loose or broken through heavy use or vandalism, bicyclists can become discouraged and not use the facility. Likewise, parking areas congested with abandoned bicycles pose a different problem. Whichever agency is responsible for the operation or access to the bicycle parking should also be prepared for the routine maintenance involved.

Several options are available for bicycle parking facilities. Simple inexpensive racks can be placed in front of a building's main entrances. Alternatively, bicycle parking can be integrated into the design of the entrance. Parking facilities are more attractive when effectively located. Because of its smaller size, the bicycle can be parked closer to the rider's destination than a car. Racks near entrances should be located so that there are no conflicts with pedestrians. Some sites need two types of bicycle parking: short-term for customers, which should be up front; and long-term for employees, which may be placed farther away.

In the event that public bicycle lockers and changing areas are considered, the related liability and routine maintenance concerns should be carefully evaluated prior to construction. It may prove simpler to encourage developers to provide such amenities during new construction, rather than 'retrofit' an existing building.

**Public Safety Concerns**

Bicycle facilities pose particular difficulty for public safety personnel. Often it is problematic for routine patrols to observe and secure bikeways from motor vehicles; the amount of access and visibility can be limited. The most effective approach to policing bicycle facilities is to use bicycle mounted public safety personnel. In this way, the parties responsible for the safety and public welfare of the facilities become familiar with the bikeway network and can provide commentary on the quality of the facilities.

Concerns about vagrants and other undesirables are an oft-cited reason for the refusal of certain facilities, such as underpasses and exclusive use trails. Proper response to these concerns is a commitment to adequate lighting and public safety patrols. For certain trails, strategic placement of lighted emergency phones and call stations may be warranted. Underpasses should be designed as short, well-lighted passages, which can be frequently patrolled to discourage use by vagrants. To reduce opportunities for criminal activity, a highly visible location with much pedestrian traffic is preferable.

**Parking Restrictions**

The issue of parking restrictions can be controversial. In situations where the available surface area does not allow for easy division between moving vehicles (bicycle and cars combined) and parked ones, disputes over access to parking facilities are common. Bicycles need to have access to adequate space on roadways at all times. Therefore, it is incompatible and problematic to allow parked vehicles in bicycle lanes.


Typical "No Parking" signs for bike lanes

Bicycle facilities along roadways with significant parking demand may create conflicts over access to limited roadway

surface. It is inadvisable to allow surface parking in striped bicycle lanes. The preferable option is to stripe parking lanes outside the bikeways wherever there is adequate right of way. In this manner, all bike lanes and similar bicycle facilities can be kept free of parked or standing vehicles at all times. This simplifies enforcement practices and also helps drivers to understand where and how on-street parking is available.

**Bicycle Helmet Laws**

Several municipalities draft and enforce their own bicycle helmet law ordinances, especially with respect to youth and children bicyclists. Consideration should be given to drafting ordinances that detail where, how and for what age children will be required to wear bicycle helmets. Provision may also be made for safety equipment to be used when riding along specialized recreational trails, such as elbow pads or minimum age requirements to use the facilities.

**Bicycle Riding Behavior**

Unlike motor vehicles where the drivers have standardized training and examinations to ensure a minimum level of competency, bicycle riding skills are often self-taught and have varying degrees of competency. To address the variable levels of riding skill, especially with regard to the younger riders, several formal education programs are available.

In addition to formal classes, public information flyers, school posters, guest appearances by public safety personnel (fire and police) can all help to increase the level of awareness about bicycling safety issues.

## *Recommendations*

The following sections are to help inspire areas of action regarding the development of a bicycle facilities policy in Cedar Park. New residential developments, featuring wide streets, local schools, parks and other areas of interest can be fitted for bicycle use by means of signage, striping, and parking racks. Greater public awareness of the available trails and routes will help to encourage residents to forgo the car in favor of the bicycle.

### *Recommended Strategies*

**Choose an Identity**

Foremost, an overall list of objectives or philosophical goals for the bikeway system should be developed. As mentioned earlier, certain municipalities opt to maximize an existing recreational element (hiking, canoeing, etc.) as the main identifying aspect of the bicycle plan. In the case of Cedar Park, devising a bikeway policy to support and sustain the identity of the community is a logical first step. Developing and designing connecting bikeways to and from schools, libraries, public parks, and churches, would help solidify the use of streets for bicycling.

**Name the Shareholders**

Determine what role the various impacted parties will play in the development of a plan. It may prove helpful to encourage the formation of a Bicycle Advisory Committee (BAC), whose presence will serve as a forum for public inquiry and debate. Proposals from the BAC can be

forwarded to the respective City personnel for future consideration. It will also help to define the role the general public will play. If coordination between several City departments is necessary (Parks, Public Safety, Public Works, etc.), establish lines of communication. Determine in advance how conflicts between various parties will be resolved.

**Secure the Funding**

Once the identity and structure of the bikeway plan is determined, appropriate resources should be designated. It may not be reasonable to begin striping lanes on streets without any popular demand. Likewise, promising an expensive freeway overpass without the interconnecting network of routes will become a "white elephant" that can damage a program's credibility. With a list of tasks and a division of responsibilities, reasonable cost estimates can be drawn up, prior to public notice or final engineering designs.

**Start Slowly**

The objectives of a bikeway plan will require time to achieve. Even in the face of insistent public opinion, rational and defensible choices should be made. Often, the public's perception of a given facility's benefit may be swayed more by misinformation and false hopes, than by hard science or reason. Instituting a thorough process of review, with ample time for comment, evaluation and revision, will provide the better means of creating a substantial product.

***Checklist of Bikeway Design***

When developing a specific route or bikeway, the following list is provided to help structure the process.

**Identify the Users**

A route network connecting homes with local schools will need to be clearly marked, and properly maintained to account for the anticipated younger age(s) of the riders. If numerous riders are expected, perhaps increased use of crossing guards or police presence to ensure that approaching motorists see the bicyclists.

**Determine the Access Points**

For restricted access routes, such as bicycle boulevards or exclusive use paths, determining where access will be encouraged may influence the number of riders. Likewise, the prohibition of parking or vehicle through movements may influence the popularity of certain routes.

**Establish Standards**

For example, should bicycle lanes be installed along a residential collector street, the width of the lanes should be preserved in a similar application elsewhere. Similarly, the design of neighborhood access to and from recreational areas or public spaces should be done with the expectation of repeated installations. The preservation of standards can raise issues of funding and maintenance that should be considered prior to final design approval.

**Involve the Public in the Process**

As mentioned earlier, public input in the discussion and review of proposed routes is critical, both to identify areas of interest, as well as provide forums for rational discussion.

**Assign Responsibilities for the Facility**

Once a design has been proposed, it should be clearly outlined which parties will be responsible for the maintenance, security, access, review and repair of the facilities where necessary. If more than one jurisdiction is involved, it is imperative that the parties agree upon their respective responsibilities prior to implementation.

**'Putting Paint on the Pavement.'**

Once a design has been agreed upon and the maintenance schedule drawn, it is important to implement the design(s) promptly. Whether internal city resources are used, or outside contractors, physical elements should be placed where participants in the process can see them. Several municipalities announce when the projects are scheduled for installation, to give interested parties a date upon which to focus.

***Next Steps***

Cedar Park has several issues of public concern that influence bikeways. Certain residential developments are requesting an improvement of bicycle facilities (or the installation of them), and others have existing routes in need of improvements. The City will need to develop a list of prioritized tasks, in line with the stated objectives of the Transportation Master Plan in general, and the Bikeways chapter in particular, to address these concerns. The process should be systematic and not unduly influenced by public outcry. For certain cities, dividing the street network into regions or sectors and proceeding from subsection to subsection is the chosen method. Others opt to develop a route map connecting known (or planned) destinations and filling in the missing elements within the network.

## *Resources*

The following list of resources provides several examples of municipal bikeway plans, design standards, and management practices. Most sources are available via the Internet. However, some copies can be provided in printed version.

**Sources for Information on Bicycle Plans and Management:**

City of Austin Bicycle Plan, Parts I & II, City of Austin Department of Public Works and Transportation, copyright 1996 and 1998.

Maricopa County Bicycle Transportation System Plan, Maricopa County Department of Transportation, Maricopa County, Arizona, copyright May 1999

Review of Planning Guidelines and Design Standards for Bicycle Facilities, ITE Technical Committee 6A-55, Institute of Transportation Engineers, copyright 1997

County of San Mateo Comprehensive Bicycle Route Plan, City and County Association of Governments, copyright December 1999

City of Austin Transportation Criteria Manual, City of Austin Department of Public Works and Transportation, March 1996

Implementing Bicycle Improvements at the Local Level, Publication No. FHWA 98-105, US DOT, Federal Highway Administration

Highway Capacity Manual, Special Report 209, Chapter 14 on Bicycles, 3rd Edition, updated 1994, Transportation Research Board, National Research Council.

**Bike Advocacy Groups:**

There are several groups concerned with advocating bicycling, either as an alternative to driving, or for recreation and/or entertainment purposes. Below are some of the national and local organizations.

Bicycle Federation of America (BFA)
1506 21st. Street N.W. #200
Washington, D.C. 20036
Phone: 202 463 6622
*www.bikefed.org*

League of American Bicyclists (LAB)
190 West Ostend Street, Ste.120
Baltimore, MD 21230
Phone: 410 539 3399
*www.bikeleague.org*

Rails to Trails Conservancy
1400 Sixteenth Street NW #300
Washington, D.C. 20036
Phone: 202 797 5400
www.railtrails.org

Texas Bicycle Coalition
P.O. Box 1121
Austin, TX 78767
Phone: 512-476-RIDE (7433)
www.biketexas.org

# PEDESTRIAN FACILITIES

## *Introduction*

The City of Cedar Park recognizes the need for better walking facilities for its citizens. Because development of residential and commercial zones is incongruous, accessible walkways and pedestrian crossings are lacking within the city.

Intersections near developments have incomplete sidewalk networks, broken surfaces, and poorly located pedestrian crosswalks. Residential street networks connect schools and parks but not necessarily in the most efficient manner for pedestrians. Proposed developments offer internal sidewalks but limited connection to adjacent areas of interest.

**Objectives**

The City of Cedar Park has the following goals and objectives with regard to the design, implementation, and management of pedestrian facilities. Foremost, it is the interest of the City of Cedar Park:

- to promote and encourage walking as a reasonable means of access to schools, parks and other areas of interest or recreation
- to provide facilities for safe and reasonable forms of exercise
- to provide for walking as a viable alternative to automobile use for short distance trips

In the pursuit of these objectives, the Transportation Master Plan has a Pedestrian Facilities chapter, which includes descriptions of walkways, their design recommendations, applications and maintenance requirements. The Pedestrian Facilities chapter also discusses methods of public involvement and methods of implementation for new facilities.

Linking schools, commercial centers, recreational facilities, and residential subdivisions with well maintained and accessible walkways will encourage the citizens of Cedar Park to walk to key destinations.

**Limitations**

The chapter on Pedestrian Facilities is not designed to provide specific routes for walking in Cedar Park. The material presented is on the macro-level and is conceptual in nature. As with other sections of the Transportation Master Plan, discussions of specific streets or routes should be undertaken in a systemic manner, based upon principles outlined.

## *Background*

To be a pedestrian is to travel on foot. In the suburbs of most American cities, this aspect of travel is often overlooked. However, a simple trip to and from the mailbox, the grocery store, or around the mall brings into sharp focus the critical elements of being a pedestrian: good walking surfaces.

Apart from comfortable shoes and shelter from the elements, pedestrians are very much concerned with the surfaces upon which they travel. Shoes and exposure to the weather can be under the control of the individual; however, potholes, broken or missing sidewalks, and poorly marked (or missing) crossings are often the domain of the local municipal government.

Where no walkways are provided people may be forced to walk in the roadway, resulting in increased pedestrian/motor vehicle collisions. The absence of sidewalks can eliminate access to all destinations for people with disabilities. Even short gaps cause sidewalks to be inaccessible.

Ensuring continuity throughout the pedestrian infrastructure improves pedestrian safety and increases the likelihood that people will choose to walk more often.

**Background Issues**

Most of the recently developed residential subdivisions have sidewalks connecting smaller collector streets to larger access roads. In areas with adequate sidewalk networks, the main concerns are maintenance of the sidewalks and the clearing of adjacent vegetation.

Outside the residential developments, pedestrians in Cedar Park face a variety of challenging problems. Many older commercial developments have sidewalk surfaces that do not meet current ADA standards. In addition, some developments emphasize private vehicle access to the detriment of pedestrians. Further still, connectivity between adjacent developments is compromised with inadequate or non-existent crosswalks and compromised lines of sight for intersections.

Cedar Park is effectively bisected by several high-volume roadways, (FM 1431, US Highway 183, RM 620, etc.), all of which pose considerable barriers to pedestrians. The continued growth of the population will require

substantial capacity improvements to the surrounding roadways.

Each physical improvement creates an opportunity to improve the pedestrian facilities. Some improvements to be carefully considered for the crossing of major roadways are: grade-separated pedestrian overpasses, coordinated push-button-activated pedestrian timing plans, refuge islands, and alternative treatments for crosswalk markings.

## *Pedestrian Facilities*

Pedestrian facilities are not limited to sidewalks and curb cuts. Important elements that enhance the viability of a pedestrian network are clearly marked crossings, consistent and visible signage, shelter from inclement weather, and aesthetic improvements. Design elements and options for the creation of pedestrian friendly space are discussed in the following sections.

### *Facilities Components*

**Sidewalks**

The most important measure of a sidewalk is its utility. Sidewalks should be placed wherever large volumes or target populations of pedestrians are present. Sidewalks operate as continuous surfaces connecting several points in a logical path.

Sidewalks should be smooth and level and provide logical connection between user spaces. Near parking lots, the position of sidewalks should complement the orientation of the parking spaces as well as provide the most efficient access. If sidewalks are not placed in a logical fashion, pedestrians carve their own footpaths, independent of the poured concrete.

Sidewalks should provide a minimum of 5 feet clear width for travel per direction. In the case of bi-directional paths (such as recreational trails), a clear space of 12 feet is recommended.

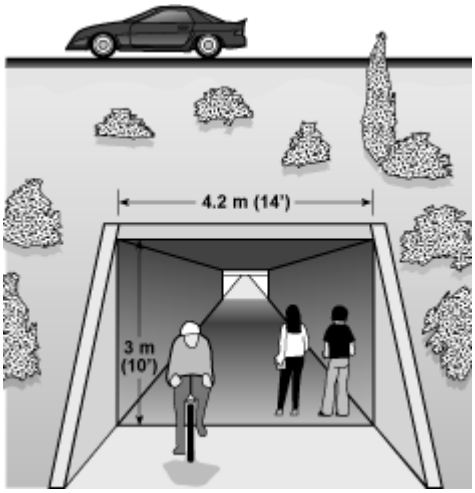
**Marked At-Grade Crossings**

Crosswalks, parking lot markings, safety channels, and pedestrian refuge islands should be located where the majority of travelers seek to cross. While this may seem self-evident, oftentimes the placement of crossings is determined by available space or financial considerations rather than safety. It should be foremost in the mind of the designer that the purpose of the marking the crossing is to improve the safety and visibility of the pedestrian.

Secondary consideration should be made to provide the shortest, most logical progression from the point of departure to the final destination (i.e. doorways, shelters or entrances). This becomes especially important when slopes and grades are an issue. Erosion and poor landscaping can result as much from unintended foot travel as from poor design.

**Separated Grade Crossings**

Overpasses and underpasses are the most common type of separated grade crossings. Many times the facilities are shared access for bicyclists as well as those on foot; however, most installations require bicyclists to dismount before crossing.




A combined use underpass

The design of these elements can be costly, especially in the case of limited right of way and the need to meet Americans with Disabilities Act (ADA) requirements for approach slopes.

Several designs have been used to address these concerns, varying from the use of switchbacks to spiral climbs, to freely available power lifts for wheelchair users. The specific design concerns of the site will vary, but in principle, all crossings, whether at grade or not, should provide the most straightforward and useful connection between destinations.

Pedestrian overpass across a large street

**Pedestrian Malls**

It is common to discuss the merits and benefits of pedestrian-only environments when reviewing pedestrian facilities. It should be noted that the designation of an area (most likely a street) for use by pedestrians is most defensible when it is an economic decision. Either the cost of vehicular traffic and congestion or the inability to safely access certain destinations justifies the added expense of restricting and rerouting vehicular traffic around the pedestrian-only area.

Pedestrian walkway in Aspen, Colorado

It is easy to confuse the designation of a pedestrian-only area, or pedestrian mall, as innately "pedestrian friendly." Unfortunately, the purpose of a pedestrian mall is not to corral or channel large volumes of pedestrians during peak periods of travel. Oftentimes, a pedestrian mall is located within or adjacent to an economic development, providing strolling passersby an environment for leisurely passage and window shopping.

Pedestrian-friendly commercial district

Contrast a pedestrian mall with typical urban street sidewalks, and it is evident the use of the same space is different. Where one encourages individuals to stop, stroll, and/or contemplate spending money, vehicles and pedestrians are processed through the other area on a transportation facility.

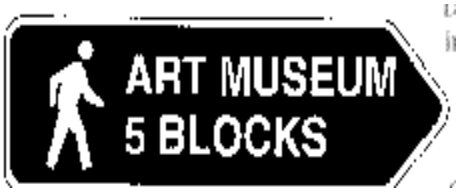
**Street Furniture**

Often pedestrian oriented areas generate discussions about the need for aesthetic elements, such as landscaped park benches and well-lit promenades.

The logic for aesthetic considerations is more along the lines of functional utility. For example, near the public park, or along a recreational path, park benches are reasonable. In locations where stopping is infrequent or even discouraged, shade trees or wind shelters may be a more appropriate element.

**Lighting and Signage**

Adequate lighting and signage is as important to pedestrians as it is to motorists. When placed at the scale of a pedestrian (4-8 feet), signage and lighting become more flexible and detail oriented in design. Unlike billboards and high voltage illumination, streetscape signage and lighting can serve dual purposes: utilitarian and aesthetic.




Directional signage for tourists

**Recreational & Mixed Use Trails**

These facilities are open to pedestrians, joggers, and walkers, usually in close proximity to a larger recreational facility, such as a park or athletic field. The anticipated volume of pedestrians using these facilities is low; otherwise, conflict between bicyclists, joggers, and pedestrians may become an issue. One solution regarding access management to mixed-use trails is to institute a standard protocol for the facility. For example, inform pedestrians to yield to bicyclists, or vice versa, and place instructional signs informing users how to announce the intention to pass.

Recreational trails along scenic routes

## *Applications*

**Commuter Access**

To function within an existing transportation network, sidewalks should be designed to provide the most direct and safe connection between destinations.

For example, in residential neighborhoods, surface streets that end in cul-de-sacs can be interconnected with paths along utility easements or between developments. These connections can provide valuable access to recreational areas or adjacent developments.

**Recreational trails**

Cedar Park is well situated to develop an attractive network of recreational trails for both hiking and bicycling. The network of trails can be designed to serve multiple interests. For example, trails can connect routes from residential developments to local parks and schools, providing an off-street means of access for students, joggers, and other users.

**Scenic/Historic Walks**

Many municipalities seek to preserve a portion of their historic identity by identifying important local landmarks. One means of organizing the presentation of the City landmarks is to develop a scenic or historic walking route.

In the case of Cedar Park, where much of the development is recent and rapid, a more appropriate focus of time and resources may be in the designation of several promenades. The City can encourage neighborhood organizations to develop holiday light displays, festival decorations, or coordinated landscaping.

**Economic Development Zones**

Another application of pedestrian-oriented facilities is to encourage the amount of time spent walking along or toward particular areas of the downtown commercial district. Many municipalities encourage visitors to developing commercial districts by placing strategic landscaping and public spaces where passersby will see them. Designating downtown areas as restaurant sections or artisan's districts can work well to encourage additional foot traffic.

## *Installation of Facilities*

The purpose of improved pedestrian access is to encourage walking, and among other results, reduces the need for additional vehicle trips. When a responsible agency considers the installation of pedestrian facilities, there exist several design guidelines

to help them. The 1990 American's with Disabilities Act (ADA) resulted in several new standards for slopes, curb cuts, minimal widths, and other physical aspects of sidewalks and walkways.

In addition, some academic study has been made into congestion management for pedestrian movements. The studies address large volumes of pedestrians occupying constrained spaces; these studies can provide parameters for the development of access corridors between large-scale parking garages, athletic facilities, and other large generators of foot traffic. A list of resources dealing with pedestrian movement and facilities design standards is provided at the end of this chapter.

**Implementation Strategies**

Establishing walkable linkages requires a well-thought-out approach that may take several years to implement. Here are four strategies to consider:

1. Regulate new development and re-development. Official policies and related ordinances can go a long way toward making walkway installation "automatic." When policies and ordinances are changed, make sure pedestrian facilities are discussed.

2. Use Capital Improvement Projects. Look for opportunities to install sidewalks as part of CIP's. In urban and/or suburban situations, add sidewalks when widening a road or installing a sewer line in the right-of-way. Typically, sidewalks add only a small amount to the overall project budget, and extra savings can result when expenses such as excavation can be lumped together.

3. Involve property owners. Many communities give property owners the option of installing curbs, gutters, and sidewalks through a Limited Improvement District (LID). With a LID, property owners pay the cost (or a percentage) over time. This can be expensive and may generate opposition. However, if they are locally acceptable, LIDs can be an important option.

4. Develop a walkway installation program. To create a truly viable walking system, start an annual walkway installation program. Where the installation of concrete curbs, gutters, and drainage structures is planned, consider including the installation of concrete sidewalks as well. Asphalt walkways are usually cheaper to install; however, they require more maintenance than concrete. Since available financial resources may limit the amount of walkway that can be installed in a given year, projects should be selected with care. Here are several things to consider:

- Give highest priority to locations used by school children, the elderly, or the disabled. Transit connections also may provide a focus.

- Give preference to requests from neighborhood groups, especially those that meet other priorities such as providing routes to school(s).

- Where a concrete curb and gutter section exists, concrete sidewalks last longer. Set the sidewalk elevation in relation to the curb.

- Evaluate the options between asphalt and concrete construction techniques. If asphalt surfaces are being considered, municipal crews may perform the work faster than outside contractors. If a sidewalk or walkway construction project is large, outside contractors may be cheaper in the long run.

**Connectivity**

A pedestrian facilities network should provide useful connection between destinations. In the case of residential sidewalks or trails, it should be high priority to provide safe, well-lighted, smooth travel paths to the local schools and parks. Most modern residential developments install sidewalks as a part of the landscaping; however, critical links may be overlooked as they lie between adjacent developments and are not part of an integrated plan.

**Routing**

For areas where pedestrian access is to be encouraged, well-placed and clearly marked directional signs should be installed. The signs can instruct individuals unfamiliar with an environment where and how to access a commercial district, train station, or regional park. In combination with satellite parking facilities, increased numbers of patrons can visit a location without undue burden on close-in surface parking lots.

**Aesthetics**

The design and location of sidewalks and other pedestrian facilities can raise much interest with regard to visual elements. The placement of a buffer zone or gardening strip between the walking surface and an adjacent roadway will help create a sense of security.

Sidewalk directly adjacent to roadway

Planting strip or buffer

Street furniture in urban and commercial areas should be designed to appeal to strollers and the mobility impaired. However, cities and towns with concerns about migrants and vandalism should select the physical elements with careful forethought, especially with regard to security and maintenance.

Aesthetic and easy to maintain

**Management of Sidewalks**

Similar to the system of surface streets and interconnecting infrastructure, walkways require constant and comprehensive management to preserve and maintain the utility, safety, and accessibility.

## *Management Basics*

Walkways are subject to debris accumulation and surface deterioration. Spot-improvement programs enable pedestrians to bring problems to the attention of authorities in a quick and efficient manner. Telephone numbers of staff contacts are included. Quick response from the city improves communications between the public and staff.

**Security Lighting and Patrols**

Depending upon the type and location of sidewalk facility, scheduled service inspections for lighting and security patrols may be necessary. For freeway underpasses, well-spaced light fixtures and adequate drainage will help to keep the facility attractive and secure. Rural trails or paths removed from populated areas should have security phones with well-maintained lights.

**Recreational Trails**

Vegetation encroaching into walkways is a nuisance and a problem. Roots should be controlled to prevent break-up of the trail surface. Adequate clearances and sight-distances should be maintained at intersections, especially for mixed-use trails. Signs advising pedestrians of vehicle access points or other hazards should be clearly visible. For areas subject to water runoff, a

maintenance program for erosion should be developed.

Local ordinances should allow road authorities to control vegetation that originates from private property. Some jurisdictions require adjacent landowners to control vegetation, or else maintenance personnel perform the work and bill the property owner.

**Public Safety Concerns**

Concerns about vagrants and other undesirables using facilities for illegal activities are an oft-cited reason for the refusal of certain facilities, such as underpasses and rural trails. Proper response to these concerns is a commitment to adequate lighting and public safety patrols. For certain trails, strategic placement of lighted emergency phones and call stations may be warranted. Underpasses should be designed as short, well-lighted passages, which can be patrolled frequently to discourage use by migrants.

An effective application of funds is to provide well marked and level crossings with properly placed signs. Resources should also be designated for the maintenance of the pedestrian crossings at signalized intersections.

## *Conclusions*

Cedar Park has an excellent opportunity to develop, encourage, and complement pedestrian-oriented facilities as the city continues to grow.

**Recommended Strategies**

Developing a concise and aggressive list of objectives for the pedestrian plan is the first step toward creating a viable and attractive walking environment.

**Organize the Shareholders**

Several different groups of citizens can provide valuable input for pedestrian planning. Schools, neighborhood and community groups, and youth-oriented recreational organizations can suggest areas of high activity where pedestrian infrastructure improvements are needed.

**Secure the Funding**

The most recent funding cycles for transportation projects have included greater portions of federal and state funding for pedestrian projects.

Improvements that address school, safety, recreational, or commuter transportation concerns are eligible for additional funding. The State of Texas Department of Transportation offers funding sources for pedestrian improvements as well.

**Combine Utility with Aesthetics**

More than most transportation improvements, pedestrian facilities are subject to concerns of appearance. To avoid having the aesthetics of a particular improvement dominate its design, focus the selection and implementation of the facilities to serve issues of connectivity and safety.

After the location and the purpose of a given element are determined, debates over its visual appearance become secondary to its utility. Ideally, a consistent, efficient design will be repeatable around the city, without becoming outmoded.

**Involve the Public in the Process**

Focus groups, appointed committees, or suggestions from the public at large are excellent sources of input for the planning process. When combined with sound engineering judgment and standards, the implementation of simple requests can make a substantial difference in a location.

## *Resources*

The following list of resources provides examples of municipal pedestrian plans and design manuals. Most sources are available via the Internet. However, some copies can be provided in printed version.

Portland Pedestrian Design Guide, City of Portland Office of Transportation, copyright June 1998.

A Guidebook for Student Pedestrian Safety Washington State Department of Transportation, copyright August 1996.

Pedestrian Planning and Design, John J. Fruin, Metropolitan Association of Urban Designers and Environmental Planners, New York, N.Y., 1971

Highway Capacity Manual, Chapter 13 Pedestrians Transportation Research Board, copyright 2000 update to 1994 edition

Interim Materials on Highway Capacity. Transportation Research Circular 212, Transportation Research Board (TRB) 1980.

Highway Capacity Manual. Special Report 209, Transportation Research Board, copyright 1994 update to 1985 edition.

### Pedestrian Advocacy Groups

There are several groups concerned with advocating bicycling, either as an alternative to commuting, racing, recreation or entertainment purposes. Some of the more established national organizations include the following:

Walkable Communities
http://www.walkable.org/

National Center for Bicycling and Walking
www.bikefed.org

America WALKs
http://www.webwalking.com/amwalks/

Campaign to Make America Walkable
http://www.prowalk.org

Partnership for a Walkable America
http://www.nsc.org/walkable.htm

# PUBLIC TRANSPORTATION

## *Introduction*

Public transportation is the organized movement of large numbers of people between destinations. Mass transportation service is most useful in regions with well-defined travel patterns, limited infrastructure, concentrated centers of population and centralized land development patterns.

The City of Cedar Park is well situated in the Greater Austin Metropolitan Region. A significant percentage of Cedar Park residents work outside the city limits, and many of them use the roadway network to travel to Austin. Public transportation offers a more efficient solution in areas where high concentrations of private vehicles use congested roadways.

## *Key Definitions*

Public transportation systems can be created with any kind of vehicle. The systems are more defined by the organization (and shared use) of transportation than by the specific mode used. This section outlines the advantages and application of several public transportation systems.

## *Rail Transportation Systems:*

The advantages of rail-based transportation systems are numerous. Trains (and related vehicles) offer the ability to transport more riders and goods for less energy. In regions with highly developed urban corridors, rail transportation can serve more passengers in the same right of way at a far greater capacity than private vehicles. The expense of rail systems limits their widespread application; however, when properly designed and in a high-use environment, rail transportation can provide the highest return on investment of all available transportation options.

**Commuter Rail**

Commuter rail networks are characterized by high occupancy and relatively high-speed travel routes that cover long distances with few intermediate stops. Commuter rail networks are designed to integrate local transportation options (light rail, bus service, etc.) with distant residential developments.

**Heavy Rail**

Washington, DC Metrorail subway

Heavy Rail (also called subways) is the most expensive and most efficient public transportation system in use. The design of heavy rail requires complete separation of the travel modes, accomplished by elevating or burying the rail lines. Heavy rail systems offer the ability to move large numbers of patrons quickly between closely spaced stations.

Given the land use pattern of the Central Texas region and its relatively small size and low density, a heavy rail transportation system is impractical. It is included in this section for illustrative purposes only.

**Light Rail Transportation**

*Light Rail in Portland, OR*

Light Rail Transit (LRT) differs from heavy rail in that the size and weight of the vehicles allows for shared use of existing roadways. Consequently, the capacity and speeds of LRT systems are not as great as those of grade-separated systems. However, LRT has become the public transportation option of choice for many communities seeking to provide improved access to established and developing corridors. LRT systems are often used as an intermediate step between bus or trolley services and heavy rail.

**Tramways and Surface Systems**


Tramways and other surface rail based transportation systems (cable cars, trolleys, etc.) are distinguished from other systems by

their capacity, length of route, and power source. Simply defined, they function in a fashion similar to fixed-route, single-unit vehicles.

## *Automobile Transportation Systems*

Advantages of wheel-based transportation systems over rail-based include the flexibility of route selection and the ability to serve non-concentrated centers of population. The utility of a rail system can be limited by its connections and access points to a given destination. Wheel-based transportation systems, generally use all available roadways, thereby greatly expanding the flexibility of service.

### Bus Transportation

Bus transportation systems are useful in connecting several destinations within a region. The advantage of bus networks over rail-based transportation is the flexibility in resource management. It is simpler and less expensive to run additional buses along a busy route than it is to expand a train.

A disadvantage of bus systems is their susceptibility to roadway hazards, including accidents, breakdowns, and general congestion. Some municipalities have created transit-only lanes for specific routes, similar to high-occupancy vehicle (HOV) lanes. As these facilities provide protection only on the most congested roadways, their effectiveness is limited.

### Circulating Shuttles

Circulating shuttles provide fixed-route service to a particular location. Typically, shuttles connect satellite parking or another transport facility (e.g. airport, train station) with a final destination. As an example, many universities operate a shuttle system between its outlying research and residential campuses and the main downtown campus. The shuttle service is free for students and staff.

### Paratransit Services

Paratransit service is the intermediate service between private vehicles and the operations

of a full-scale mass transportation agency. Taxicabs, horse pulled carts, rickshaws and vanpools are in this category. Para transit does not exclusively apply to a disabled clientele.

**Fixed Route**

An important distinction to be made among public transportation services is the route assignments. Fixed guideway systems, such as rail, do not deviate from established routes and stations. The same restrictions can be placed upon wheel-based systems. It is common for bus and trolley operators to refuse to pick up or drop off patrons away from designated stations. This is done for reasons of security and schedule, among others.

**Demand-Response Services**

As a network or public transportation system expands, its ability to offer frequent service becomes limited. When this occurs, a secondary carrier organization offers the intermediate transportation services.

In contrast to fixed-route systems, demand response networks can increase their service area (and ridership) by reaching patrons at or near their points of origin and departure. By its nature, demand-responsive services are more expensive to operate and tend to use smaller, less expensive vehicles.

## *Benefits of Public Transportation*

The benefits of mass transportation are numerous. For regions experiencing rapid economic and residential growth and high demand for efficient access to major business centers, mass transportation offers a proven solution to many issues. The use of a single vehicle (or chain of vehicles) to move many people reduces congestion, automobile emissions and parking demand. An efficient mass transportation network increases the utility of existing roadways, especially where there is limited right-of-way for additional lanes. Where efficient public transportation networks operate, land development uses can become denser, helping to create a vibrant, identifiable commercial and/or residential urban district.

## *Local Concerns*

The City of Cedar Park participated in the service area of the regional mass transportation provider until the year 2000. Since withdrawing from the Cap Metro transportation service area, Cedar Park has continued to grow rapidly and experiences severe roadway congestion on certain streets during peak hours.

A public transportation needs assessment study is being conducted by Capital Area Rural Transportation Systems (CARTS) in Williamson County. Cedar Park is participating in the study to determine the community needs and possible benefits from public transportation.

The City of Cedar Park should now carefully review and direct the development of its future mass transportation services. Recent

proposals for regional LRT and/or commuter rail networks should be examined carefully. The results of the regional public transportation needs assessment study should be evaluated. In addition, small scale transportation systems, such as taxi services, fixed route shuttles and outreach programs may prove beneficial.

It is in the interest of Cedar Park to pursue the development of suitable public transportation services for its residents. The Central Texas region is expected to grow in population and in roadway congestion for the foreseeable future. Cedar Park will benefit greatly from more efficient and less environmentally damaging transportation options.

## *Resources*

The following resources were consulted in the development of this section. Several municipal and regional public transportation providers post their contact information on the Internet. The following websites provide useful information about the various mass transportation systems in operation and the federal policies for the oversight, funding, and regulation of public transportation services in the United States.

Capital Metropolitan Transportation:
http://www.capmetro.org/

Capital Area Rural Transportation Systems
http://www.rideCARTS.com/

Dallas Area Rapid Transit
http://www.dart.org/

San Francisco Bay Area Transit Information
http://www.transitinfo.org/BART/

Portland, OR Tri-County Metropolitan Transit
http://www.tri-met.org/

United States Department of Transportation – Federal Transit Administration
http://www.fta.dot.gov/

Texas State Department of Transportation – Public Transportation Services:
http://www.dot.state.tx.us/insdtdot/orgchart/ptn/ptninfo/pubtrans.htm

American Public Transportation Association
http://www.apta.com/

The following texts are valuable for their comprehensive review of public transportation systems and operating characteristics.

Public Transportation, edited by George Gray & Lester Hoel, Prentice Hall Inc., Englewood Cliffs, NJ, copyright 1992

Urban Public Transportation – Systems and Technology, Vukan R. Vuchic, Prentice Hall Inc., Englewood Cliffs, NJ, copyright 1981.

Light Rail Transit, Special Report 161, Transportation Research Board, National Research Council, National Academy of Sciences, Copyright 1975.

# TRANSPORTATION SYSTEM MANAGEMENT TECHNIQUES

Traffic management techniques involve more than the efficient throughput of vehicles on city roadways. Management practices should integrate the interests of all affected parties, including the traveling public, the commercial community, and the economic and environmental concerns at large.

Traffic management is a broad inclusive topic encompassing resource utilization, infrastructure, personnel, and data management. It is not merely the traffic engineering tasks performed by a municipality. Strong consideration must be given to the issues associated with transportation planning. These considerations include, but are not limited to public safety, economic development, congestion management, travel demand, environmental constraints, etc.

## *Chapter Objectives*

This chapter will provide a brief outline of practices employed by city governments to maintain and manage various elements of their transportation infrastructure. Some of the examples are taken from larger, established cities with considerable resources. Others are recommended practices that apply to any size municipality. The suggested or recommended practices at the end of this section are specifically directed at the challenges facing the City of Cedar Park.

## *Physical Infrastructure*

Maintenance of the physical infrastructure is a critical aspect of transportation management. Most municipal infrastructure management agencies prefer to schedule routine repairs and inspections instead of patching and repairing “bad locations.”

A schedule for inspection, cleaning and street repairs will enable city personnel to efficiently use limited resources. A calendar for repairs and reviews will also provide valuable information to concerned citizenry.

**Street Sweeping**

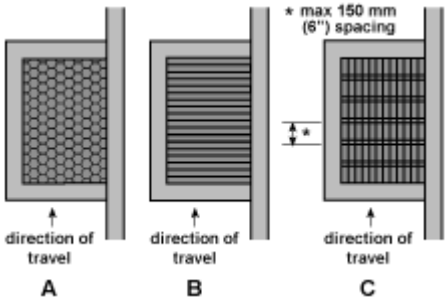
Accumulation of debris (leaves, oil spills, rubble and glass) on the road can impair driving in general and visibility of intersection markings and signage, especially during wet conditions. For bicyclists in particular, any debris along the side of the travel lanes can cause tires to slip or require riding within the vehicle travel lanes to maintain stability.

Therefore, any obstruction of the travel lanes should be cleared as soon as feasible. Some municipalities require tow vehicles to clean the site of roadway accidents immediately after removing the vehicle from the collision site.

**Resurfacing and Patching**

Regularly scheduled roadway resurfacing is necessary to provide uniform improvements to the existing roadways. Older roads, especially those built according to discontinued standards, should be reviewed with an eye to upgrading deficient sections to modern standards. When an existing roadway or section is placed under a new jurisdiction, this is the best time to document the condition, date of construction and estimated necessary repairs.

Overlays and patches should be carefully constructed to cover the entire roadway surface. This helps prevent uneven transitions between lanes and excessive wearing. Patches should be placed and inspected to insure a smooth transition from the existing roadway surface across the new patch. If new or existing grates and inlets are involved, care should be taken to reseat the grate so that its top surface is flush with the new pavement surface. In locations with bicycle lanes (or anticipated bicycle travel), bicycle compatible grates should be installed to avoid mishaps and pinched tires.




Drainage grates that are bicycle friendly

**Effective Signage and Markings**

Intersection signage is critical to properly informing drivers, during the approaches and while traversing intersections. Stop bars, crosswalks, signal heads, and movement prohibitions should be well marked and routinely inspected and retouched. In locations with high volumes of pedestrians, bicyclists or school age children, special signage should be placed to alert drivers.

Signage and street markings should be placed according to the guidelines of the Texas MUTCD. In locations with high volumes of children, advance signage and clearly defined street markings are critical. Cedar Park may wish to consider developing a comprehensive street marking and striping policy to address areas of concern (i.e. school zones and pedestrian crosswalks).

## *Electronic Infrastructure*

Managing transportation infrastructure is no longer limited to concrete pavements and asphalt. Recent improvements in operations and data collection methods have led to digital controls and integrated computer networks.

Similarly, older technologies are being systematically replaced with newer options. In-pavement magnetic loops are being phased out while video detection and automatic detection devices for pedestrians and bicycles are gaining popularity. Traditional incandescent bulbs for signal heads are being replaced by more efficient light emitting diodes (LED's). New technologies offer increased durability and lower overall maintenance costs.

**Intersection Signal Timing**

The timing and phasing of signalized intersections should be reviewed periodically, especially in areas of rapid development or increased commercial activity. Most intersections should be reviewed for appropriate timing and phasing every six months, with more heavily traveled intersections reviewed more frequently. The signal heads and controls should be uniform wherever possible to facilitate ease of coordination and minimize confusion on the part of those accessing and servicing the hardware. In locations of due east or west travel, back plates and directional signal heads may be advantageous. Locations with concerns about wind and severe weather concerns should be designed with appropriate mast arm and pole dimensions.

**Signal Optimization**

Timing and signal coordination within a roadway network is important to the overall functioning of the through and local traffic. Poorly timed signals will result in increased congestion, poor flow and probable creation of long queues, awaiting access to a specific intersection. As traffic volumes continue to increase, signal coordination can designate high priority traffic "corridors" for major roadways and increase the throughput volume of critical roadways.

**Signal Preemption**

Signal preemption plans allow emergency services personnel (Fire and ambulance drivers) to operate a specific timing plan for each signalized intersection in the network.. The preemption equipment is placed in each vehicle and upon operation will provide radio access to the intersection timing controls. The emergency vehicle is presented the "green ball" while opposing traffic is stopped.

## *Modifying Driver Behavior*

Driver behavior can be a cause for numerous traffic and transportation relatedness issues. Drivers attempting to avoid congested intersections compound the problem by using smaller roads to access their final destinations. Inadequate signage and enforcement can lead to habitual traffic violations such as red light running and rolling stops through intersections.

It is useful for municipalities to have a means to influence driver behavior. Many municipalities attempt to inform their citizenry in public education efforts instead of aggressive law enforcement. The following sections discuss methods available to influence driver behavior, both in global and individual applications.

**Travel Demand Management**

If surrounding land development patterns separate large-scale residential communities from commercial or retail centers, routine tasks require additional vehicle trips. The term "travel demand management" refers to reducing the total number of necessary trips.

Travel Demand Management techniques include encouraging mixed use developments and shared travel routes to and from large economic centers. In addition, programs to encourage: carpooling, job sharing, or telecommuting are useful in reducing the number of peak hour trips. The objective is to lower overall travel demand, which results in an absolute reduction in the need or desire for extra trips. In lieu of reducing demand, distributing it evenly throughout the day is a secondary goal.

In the case of shared jobs or telecommuting, any reduction in the number of 8:00 AM start times for work shifts will reduce the number of morning peak hour commute trips. Similar scheduling for evening and weekend shifts is also recommended.

**Access Management**

Access is the availability of entrances into a commercial or residential development. Therefore, access management is the conscious restriction or regulation of the number of access points between a development and the adjacent roadway network. Most discussions of access management involve the placement and number of driveway curb cuts, although the application can also include the location, size and function of interior service roads.

When too many access points are allowed, especially near an intersection, conflicting vehicle movements result. In the interest of providing safe and reasonable access to a site, city planners should review development plans with respect to the entire impacted corridor and not the single development. Wherever possible, cooperation and consultation between adjacent landowners is encouraged to avoid conflicting designs.

**Police Enforcement**

Consistent and reliable enforcement of the traffic laws will help to address numerous popular and public concerns about traffic issues. In areas with complaints about speeding, excessive traffic volumes, reckless or inconsiderate driving, a responsive police force can do much towards gaining the public's trust and compliance. Focused speed studies (using radar trailers and traffic counters) can be combined with a willing and accessible police department to discourage speeding on residential streets.

**Traffic Calming**

There are instances where the number of aggressive drivers is greater than human resources can address. Many cities and towns have implemented various self-enforcing speed and volume control devices. The majority of these measures are referred to as "traffic calming." These self-enforcing physical devices can assist law enforcement in influencing driver behavior.

Traffic calming is oftentimes controversial and complicated to discuss. Most traffic calming measures are applied to residential streets. Certain measures can be applied to higher volume roadways as well. Broadly defined, the goals of traffic calming measures as follows:

- to slow down the average vehicle speeds for a particular roadway
- to address excessive volumes for a particular roadway
- to remind or reinforce the residential nature of specific roadways

Traffic calming measures are designed to slow down or impact all traveling vehicles. In practice, this can lead to reduced access and response times for emergency and law enforcement personnel. Careful consideration must be given to any proposed traffic calming device, especially if the roadway under review provides critical access for emergency personnel.

In response to the above concerns, several municipalities involve representatives of the Fire, Police and Emergency Services Departments in the review of proposed traffic

calming measures. By involving all affected parties, including concerned members of the public, compromises can be developed, prior to a final design plan.

Included in Appendix C of this document, is a more detailed discussion of traffic calming practices and techniques.

## *Data Management*

Efficient data management can be advantageous to a city's administration. Many municipalities have full time personnel monitoring and updating the assembled information so that city staff can effectively use the resource. Computerized databases for reported accidents, damaged streets, missing or broken signage, sidewalks, street lights and traffic signals can be integrated and shared across departments. In addition, proper data management can assist in the application process for federal funds.

Several software applications are available for cataloging and documenting data. It is helpful if similar or compatible data management applications are used across city departments allowing for easy information exchange.

**Accident Record Database**

Traffic accident studies are helpful in documenting areas of concern. Several traffic engineering studies and review processes use accident information to determine possible courses of action. Accident patterns and frequency are used extensively to determine areas within a city that need careful review or infrastructure improvements.

Many municipalities record the reported accidents for graphic display to provide a visual clue to travel flow patterns and high volume locations in the city. It is possible to digitize traffic accident data collection. Modern computer applications can manage, analyze and present the results in an efficient manner.

**Speed Studies**

Speed studies are useful in documenting travel speeds along critical roadways. When speed studies are conducted, using radar technology, a reliable database of travel speeds is created allowing for fairly sophisticated modeling and analysis.

**Volume Studies**

Documenting volumes on residential and arterial streets enables city governments to track changing travel patterns. This information is especially useful when handling inquiries about excessive residential volumes or complaints about cut-through traffic.

**Emergency Response Routes**

Emergency services personnel depend upon the roadway infrastructure. Route maps for emergency and public safety services are helpful for planning purposes. Route maps should provide lists of primary and secondary response routes.

Designating primary and secondary response routes will help planners and engineers evaluate proposed changes and the impact to EMS. To protect the integrity of their

emergency services, certain municipalities declare elements of the EMS response routes to be off limits for invasive or aggressive traffic management techniques (such as traffic calming devices).

## *Neighborhood Association Contacts*

Contact with citizens is a valuable resource for city personnel. Concerned citizens provide prompt information regarding problems, failures or general concerns, often with greater detail than routine inspections by staff. In addition, a respectful relationship with the public can serve as an effective conduit to communicate information regarding city concerns and limitations.

One means to organize and coordinate public input is to encourage and support the development of neighborhood associations. Designating a single point of contact and general contact information can streamline the solicitation of public input.

When neighborhood associations have an issue or concern, the representative(s) are familiar to the city personnel (and with the city organizational structure), and are better positioned to get results. Creating a neighborhood association registry is one step towards formalizing the role the community groups play within the administration of city resources.

**Conclusions**

This section summarizes in broad terms the practices and philosophies reviewed in the preparation of this document. The majority of recommended practices come from municipal plans and organization charts.

Some of the recommendations are costly to enact, either in terms of economic or human resources. However, proper organization and efficient use of available resources can save time and money over spot improvements or "fire drill" style management practices.

## *Recommended Strategies*

**Physical and Digital Infrastructure**

Consensus among the reviewed municipalities is that routine maintenance and scheduled inspections is preferable. This practice is applied equally to electronic and physical infrastructure. Inspection and review of computer files, applications and hardware as well as field inspections of signal heads, detection loops, timing plans and striping should be regularly scheduled activities.

There is near consensus on the need for routine review. In the experience of several municipalities, ongoing maintenance is highly preferable to rapid responses to crisis "hot spots."

**Behavior Modification**

With respect to altering the behavior of drivers, residents or citizenry at large, local governments have limited influence. However, several municipalities have undertaken a proactive approach.

Posting radar trailers which display the travel speeds of approaching vehicles have proven useful tools to inform drivers. An alternative approach is to provide concerned citizens with battery operated hand held radar guns to conduct informal speed surveys.

**Data Management**

Many data intensive efforts are expensive, usually requiring several full time personnel to update, integrate and access the database(s). Fortunately, widespread use of popular computer applications allows for more individuals to participate in the input/retrieval aspects of information management.

It is recommended that key personnel have the authority and responsibility to make major changes in the central database(s). In this manner, few parties are likely to impact the sensitive data, while several departments can enjoy "read only" privileges.

**Public Involvement**

Public outreach programs, including personnel from fire, police, public works or parks departments, are useful ways to communicate with the community. Some cities offer organized presentations, billboard announcements and flyers at community centers, and/or phone number hot lines to contact the public. Other cities create citizen advisory councils to help focus and direct public input.

## *Resources*

The following list of resources provides examples of municipal transportation management techniques. Most sources are available via the Internet. The following websites were reviewed in the development of this comprehensive transportation plan:

### State Transportation Plans:

Oregon State Department of Transportation
www.odot.state.or.us/tdb/planning/

Ohio State Department of Transportation
www.dot.state.oh.us/planning/

Washington State Department of Transportation
www.wsdot.wa.gov/PPSC/WTP/

### Municipal Transportation Plans:

City of Portland Metropolitan Region:
www.metro-region.org/transpo/transpo.html

City of Austin, TX Transportation Planning and Development Department
www.ci.austin.tx.us/planning/default.htm

City of San Jose, CA Department of Transportation
www.ci.san-jose.ca.us/dot/s_transportation.htm

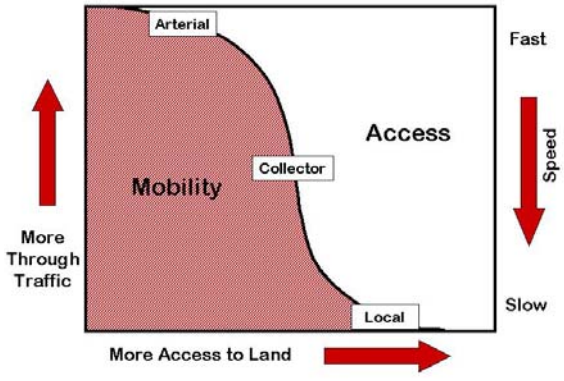
# APPENDIX A –

# FUNCTIONAL CLASSIFICATION OF ROADWAYS

## *Functional Classification*

Functional classification is the process by which streets and highways are grouped into classes according to the character of service they are intended to provide. Individual roads and streets do not operate independent of each other. Most travel involves movement through a network of roads. The need for access to destinations as well as the mobility to traverse distances in reasonable time is a key element in the relationship of the functional classes. A local roadway is to provide access to a residence. An interregional freeway is to provide uninterrupted travel for extended distances. In between are the arterials and collector streets that provide intermediate levels of access. The following figure illustrates the relationship of mobility and access to the basic functional classes.

**Relationship of Mobility and Access to Roadway Classification**




Local roadways can be designed to discourage through traffic. Local networks can have limited points of entry, curvilinear street designs, and narrow roadway widths. Identifying the purpose of a roadway is the first step toward a successful design.

Additionally, traffic volumes and land use are two important elements of roadway design. These elements are interrelated and change over time. A rural road could one day become an arterial providing critical access to a commercial development, drastically changing the daily traffic volumes.

The functional classification should represent both existing and future roadway conditions. This classification is made at the time of preliminary platting on new developments. Afterwards, an official amendment is needed to change the classification.

**Functional Classifications Defined**

Urban roadways are stratified into three basic classes: arterials, collectors and local streets. The following sections discuss functional classifications by characteristics and purpose.

The City of Cedar Park adopted the Austin Transportation Criteria Manual (TCM) for the

purpose of establishing rules and regulations for design and development of roadways within its city limits and extra-territorial jurisdiction.

The TCM provides for further break down of the three major street classifications. The TCM functional classifications include local streets, multiple types of collectors, arterials and freeways. Alleys and parkways are included in the discussion of the overall functional characteristics of the network. This document includes a slightly modified list of classifications

**Arterial Streets**

The primary function of arterial streets is to provide a high degree of vehicular mobility. They may also serve a minor role to provide land access. The nature of arterial streets requires that their designs limit property access and on street parking. This is to improve capacity for through traffic.

Arterial streets are used as primary bicycle, pedestrian, emergency response routes and transit routes. There are two classifications of urban arterial streets: major arterial and minor arterial. Because the function of both types is similar, the designs of major and minor arterials are usually also similar.

Exceptions to this rule are freeways and expressways. While freeways and expressways are typically classified as major arterials, they have unique geometric criteria that control their design, and highly regulated access controls that limit access to adjacent land uses.

**Major Arterials**

On a statewide level, the most important highways and roads that connect cities to one another are usually designated as major arterials (or principal arterials). Major arterials travel across and through cities and towns, and are the primary “arteries” for intra-urban movement within large cities.

Cypress Creek Road – Major Arterial

One of the key characteristics of urban major arterials is the high degree of connectivity they provide within the urban area. These streets serve as major access routes to regional destinations such as downtowns, universities, airports, regional shopping centers, and similar sites within the urban area. Major arterials typically have four or more lanes and, with the exception of freeways and expressways, have sidewalks, planting strips, striped bicycle lanes, and raised median islands.

**Minor Arterials**

Minor arterials connect the nearby rural areas to cities and function within cities as conduits for a large proportion of intra-urban trips. These streets provide the next level of urban connectivity below major arterials. Minor arterials can provide a fairly high degree of intra-regional connectivity; in most cases their main role tends to be serving intra-city mobility. A typical minor arterial contains two to four lanes plus a center median, with bike lanes, planting strips (in some cases), and sidewalks.

Anderson Mill Road – Major Arterial

**Collector Streets**

The primary function of collector streets is to assemble traffic from the interior of an area and deliver it to the closest arterial street. Collectors provide for both mobility and access to property and are designed to fulfill both functions. They usually serve shorter trip lengths and have lower traffic volumes than arterial streets. Collector streets are also used as important emergency response routes and are frequently used as transit routes. There are several classifications of collector streets: major collector, neighborhood collector, primary, commercial or industrial. While the function is essentially the same, the neighborhood collector classification is applied only in residential neighborhoods. Separate guidelines for neighborhood collectors provide for design flexibility to preserve the livability and character of residential areas.

**Major Collectors**

Major collector streets can be found in residential, commercial and industrial areas. Typically, major collectors have greater right-of-way and paving widths, and wider traffic lanes than neighborhood collectors. Major collectors frequently have continuous left turn lanes and are normally provided with sidewalks, planting strips, and striped bike lanes; provision for on-street parking varies by location. Major collectors may be designed with raised medians to reduce conflicts, provide a pedestrian refuge, restrict turning movements, limit land access, or to furnish an aesthetic separation between traffic lanes.

Buttercup Creek Boulevard – Minor Arterial

**Primary Collectors**

Collector streets provide access to property. The function of a primary collector is to provide access from local streets and neighborhood collectors to nearby arterials. Primary collectors also carry traffic from high traffic generating developments. Multi-family developments should be located on these facilities.

The daily traffic volume on primary collector streets averages between 2,000 and 6,000 vehicles. Speed limits are lower than on arterials and do not exceed 40 miles per hour. Spacing of the collectors should not be further than one-half mile apart. Primary collector streets can have two to four lanes.

Primary collectors are designed for through movement and often have restricted parking. The street designs can allow for bike lanes and transit stop curb cuts. Traffic calming measures are allowed. To augment the residential appearance of the roadway, sidewalks and planting strips are encouraged.

**Industrial Collectors**

Industrial collectors provide the access to light industrial and warehouse districts. The classification is unique because the design features required are different from other collectors. Large vehicles often use these facilities, requiring wider lanes and circulation area.

Pioneer Ridge Blvd. with 10' Off-Road Trail

The average daily traffic volume on industrial collectors is above 4,000 vehicles per day. Speed limits are not usually in excess of 35 miles per hour. Spacing of the industrial collectors is per the location of the industrial land uses.

Industrial collectors restrict parking and limit driveway access. Traffic calming measures are inappropriate. Sidewalks and planting strips are required. Medians and turn lanes are encouraged. Bicycle lanes are generally discouraged.

**Commercial Collectors**

Commercial collectors streets provide access to commercial developments. As with industrial collectors, often the vehicles that will commonly use this facility are large.

The average daily traffic volume on commercial collector streets is usually greater than 10,000 vehicles per day. Speed limits are similar to the industrial collectors and do not exceed 35 miles per

hour. Spacing of commercial collectors is based on commercial land uses.

Lakeline Boulevard – Major Arterial

Commercial collectors limit parking and driveway access. Traffic calming measures are inappropriate. Turn lanes and medians are optional. Required components include sidewalks and planting strips.

**Neighborhood Collectors**

Neighborhood collectors are found only in residential neighborhoods and provide a high degree of access to individual properties. This street type does not apply to commercial and industrial areas, or to most multifamily residential areas. As a rule, both right-of-way and paving widths are narrower than major collectors.

The function of neighborhood collectors is to gather traffic from residential streets to a higher facility. The neighborhood collectors may serve multiple sections, but remain within one subdivision. Neighborhood collectors provide more access to adjacent properties than do the primary collectors.

The average daily traffic on neighborhood collector streets ranges from 500 to 3,000 vehicle trips per day. Speed limits are limited to 35 miles per hour. Spacing of neighborhood collectors should not be further than one-half mile apart. Neighborhood collector streets are two lanes wide.

On-street parking is allowed on neighborhood collectors. Single-family direct access is discouraged, but access is allowed for neighborhood facilities such as schools and public buildings. Traffic calming measures are allowed. Sidewalks and planting strips are required. Medians and turn lanes are discouraged.


Cluck Creek Trail – Residential Collector

A great deal of flexibility exists for on street parking on this street type. On most neighborhood collectors, bicycles share the travel lane with other motor vehicles, eliminating the need for striped bicycle lanes. Exceptions to this can occur in situations where traffic volumes or speeds,

roadway geometry, or other factors suggest that striped lanes will provide a safer design.

**Local Streets**

Local streets provide direct access to adjacent property and the collector network. They are designed to allow local access to and from a neighborhood. Local streets are not designed for high traffic volumes or speeds. Through traffic is discouraged, although neighborhood traffic will use these facilities. Local streets do not continue across residential developments.

The average daily traffic volume on local streets is less than 1,500 vehicles per day. Statewide speed limits on residential streets are 30 miles per hour. Local streets are limited to two travel lanes.

King Street – Residential Street

On-street parking is allowed on local streets. Traffic calming measures are allowed. Sidewalks are mandatory, as well as planting strips between the sidewalk and street. While bicyclists will use these facilities, the striping of a bicycle lane is optional. Medians and turn lanes are prohibited.

**Alleys**

Alleys are designed to provide residential and service access to properties. Alleys can be in residential or commercial areas. Narrow alleyways should be one-way and well marked with signs, striping and lighting.

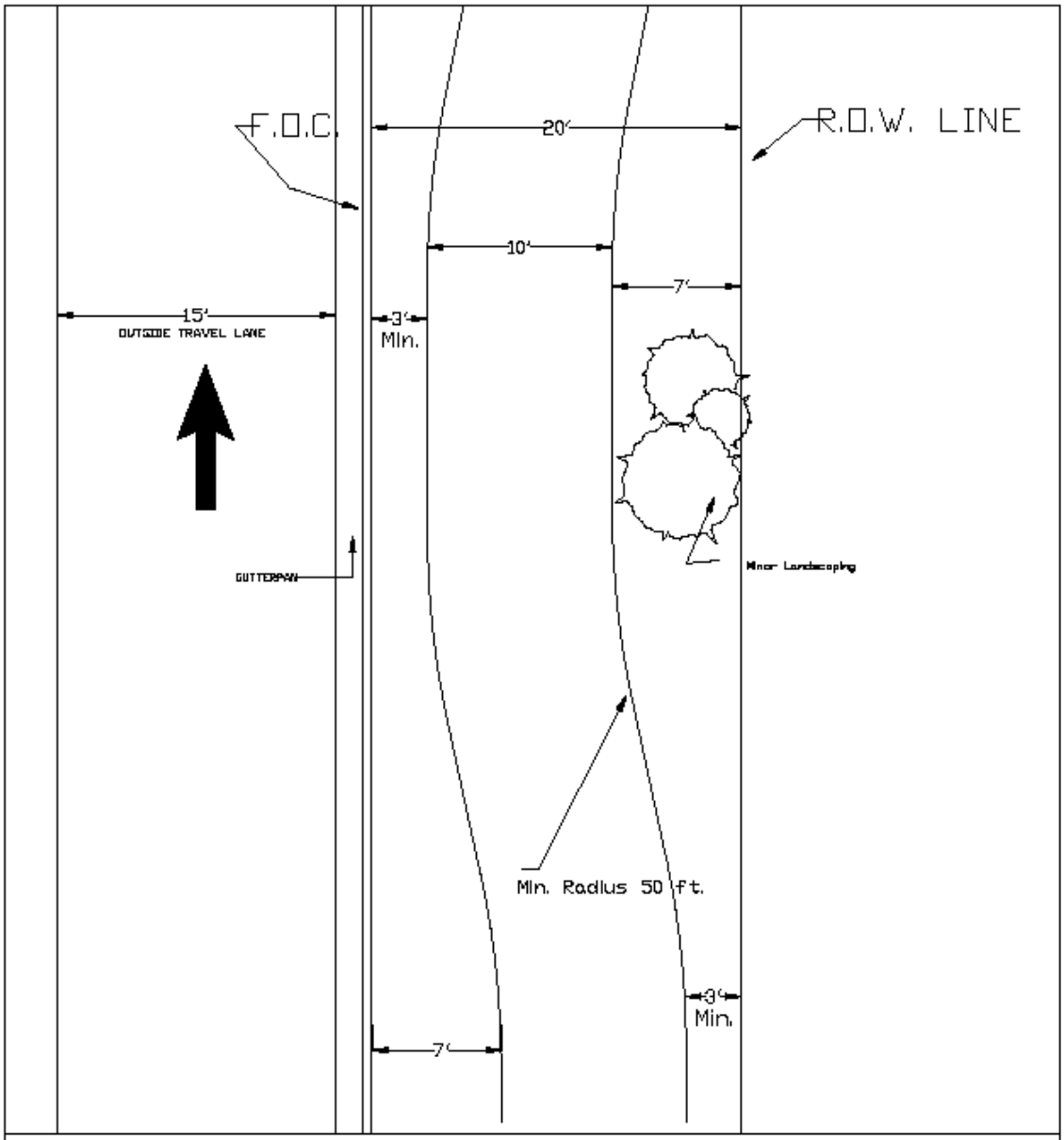
On-street parking is prohibited on alleyways. Other roadway components, such as medians, sidewalks, traffic calming devices and planting strips, are discouraged. Under carefully consideration, alleys can be useful bikeways with adequate signage and marking.

# APPENDIX B –
# SAMPLE ROADWAY CROSS SECTIONS

The following sample roadway cross sections were taken from the City of Austin Transportation Criteria Manual, which was adopted by the City of Cedar Park in the fall of 2000. The Austin TCM serves as the primary reference document for transportation design standards in the City of Cedar Park with two notable exceptions:

1) In the case of specific modifications or substitution to the TCM recommended design element, OR
2) In the case of omission of the design from the City of Austin TCM where the City of Cedar Park is required to cite an alternative source.

The following diagrams are provided with limited commentary. Their presence in this document is to provide supplemental information for interested parties. Further inquiry as to the limitations, applications and proposed modifications of the designs should be directed to City staff.




Detailed View of recommended typical off-road trail design

Minimum curve radius of 50 ft.

Design speed of 20 mph

**Figure 1-22 – Local Street for Land Use categories SF – 1 through SF – 6.**

This design is for a local residential street with direct access to adjacent properties. The City of Cedar Park proposes to apply this cross section as the standard width and right-of-way allocation for local streets within higher density residential developments. It also has application in areas of constrained right-of-way.
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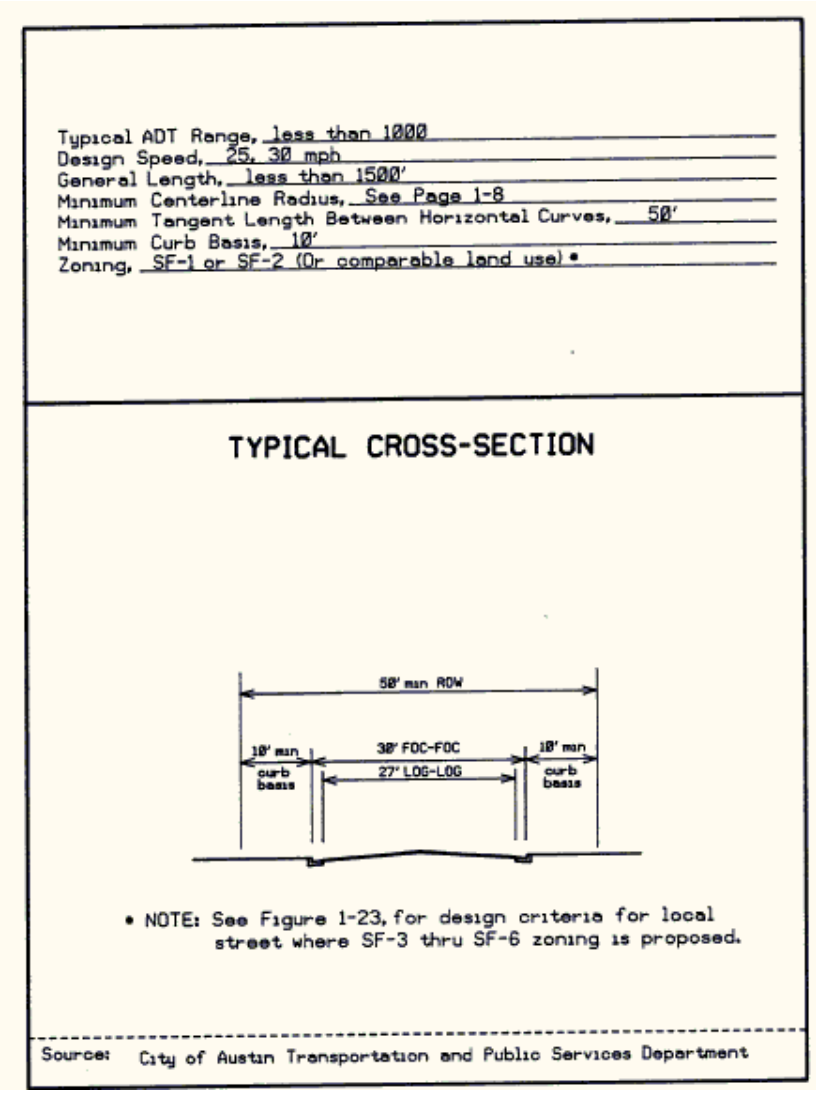



FIGURE 1-22 Higher Density Local Street Cross Section

**Figure 1-27 – Local Street for Land Use categories SF – 1 and SF – 2.**

This design is for a local residential street with direct access to adjacent properties. The City of Cedar Park proposes to apply this cross section as the standard width and right-of-way allocation for local streets.

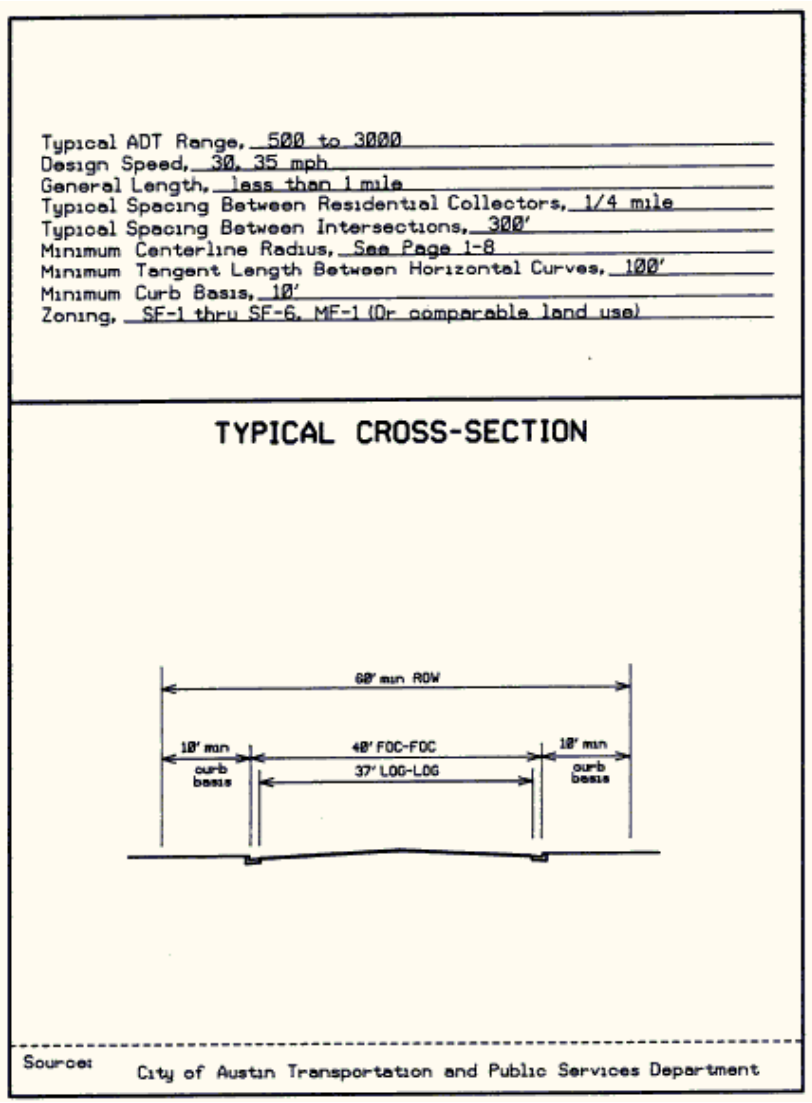



FIGURE 1-27 Local Street Cross Section

**Figure 1-28 – Neighborhood Collector Street.**

This cross sectional view is for a residential collector street. This design does allow for direct driveway access to adjacent properties. The City of Cedar Park proposes to apply this cross section as the standard width and right-of-way allocation for collector streets that connect local residential streets (figure 1-23) with higher volume arterial and commercial roadways.

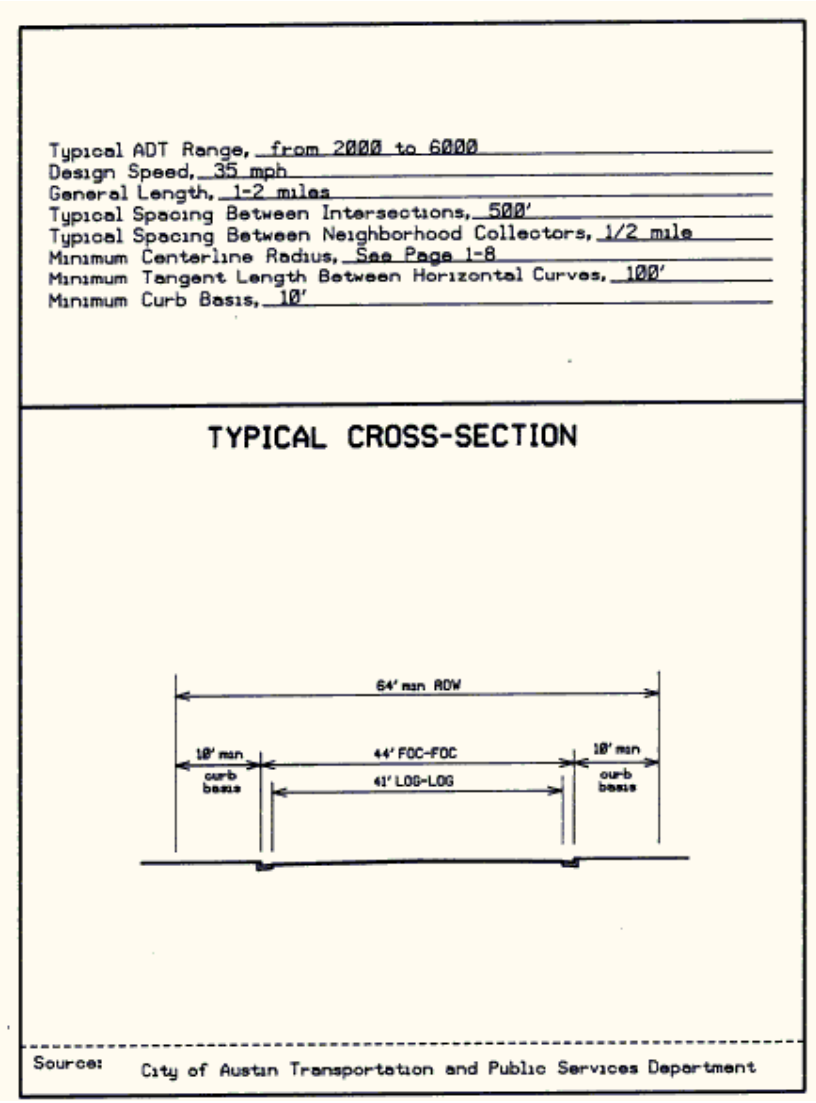



FIGURE 1-28 Residential Collector Street Cross Section

**Figure 1-29 – Commercial Collector Street.**

This cross sectional view is for a commercial street. This design is for higher volume, larger dimension vehicles (such as delivery trucks) and has limited direct driveway access points. The City of Cedar Park proposes to apply this cross section as the standard width and right-of-way allocation for commercial roadways served by minor and major arterials at the adjacent intersections.

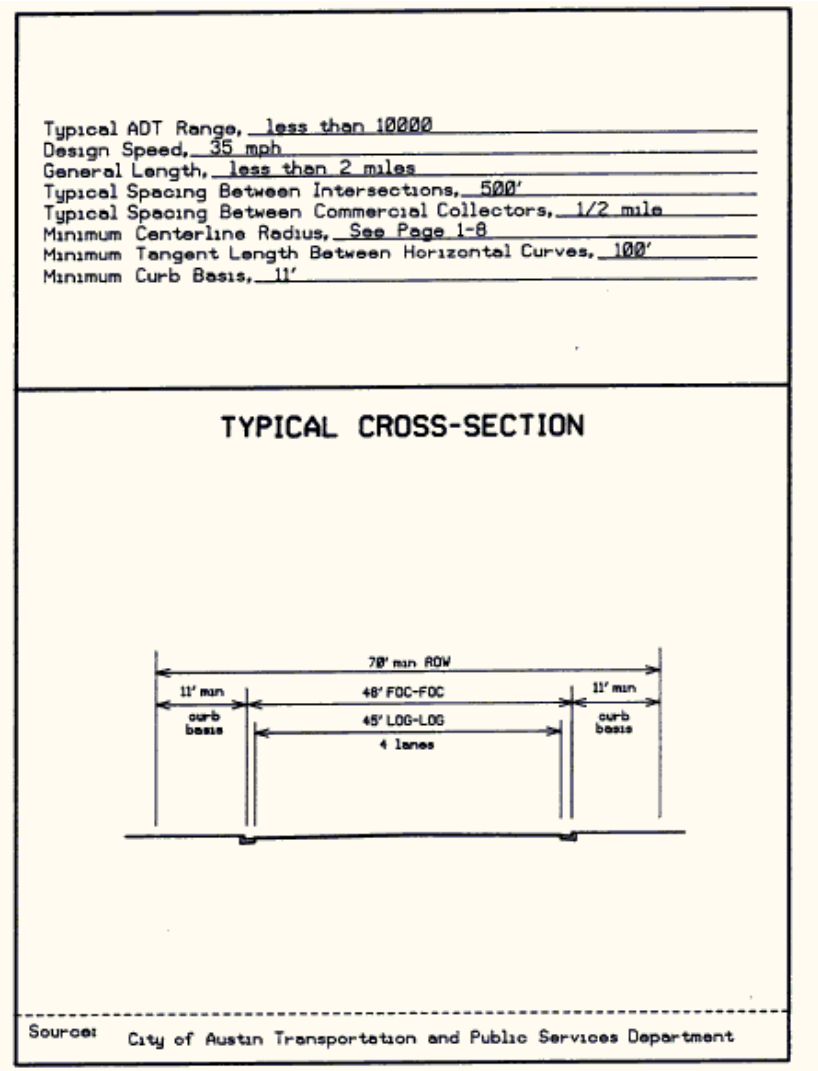



FIGURE 1-29 Commercial Collector Street Cross Section

**Figure 1 – 34A Minor Arterial Roadway.**

This cross sectional view is for a two lane minor arterial roadway with wide outside lanes. The additional width of each travel lane is to provide for adequate clearance between bicycles and/or parked vehicles. Direct driveway access to residential properties is prohibited in this design. Limited driveway access for commercial developments is allowed. The City of Cedar Park proposes to apply this cross section as the standard width and right-of-way allocation for relatively high volume minor arterial roadways where there is constrained right-of-way and which connect local collector streets with higher volume arterials.

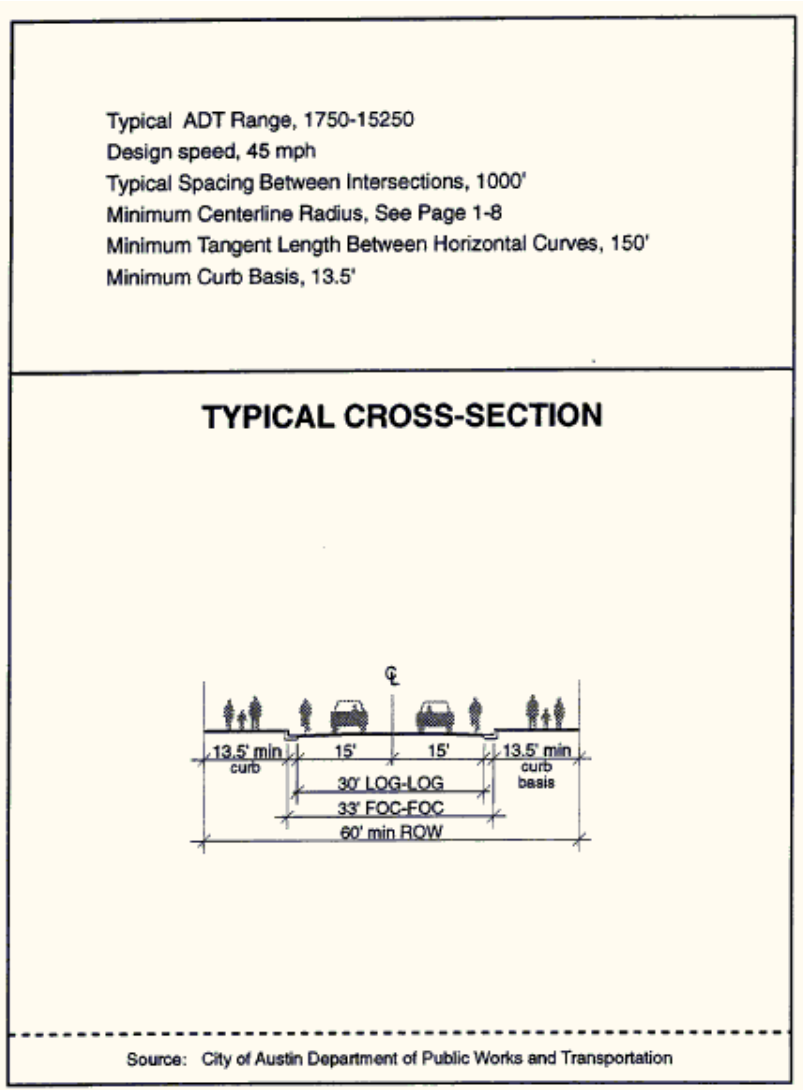



FIGURE 1-34A Minor Arterial Roadway Cross Section

**Figure 1 – 34B Minor Arterial Roadway Alternate Design.**

This cross sectional view is for a two lane minor arterial roadway with striped bicycle lanes. The presence of bicycle lanes precludes on street parking. Similar to the proceeding figure, direct driveway access to residential properties is prohibited in this design. Limited driveway access for commercial developments is allowed. The City of Cedar Park proposes to apply this cross section as ion areas of constrained right of way with significant bicycling demand.

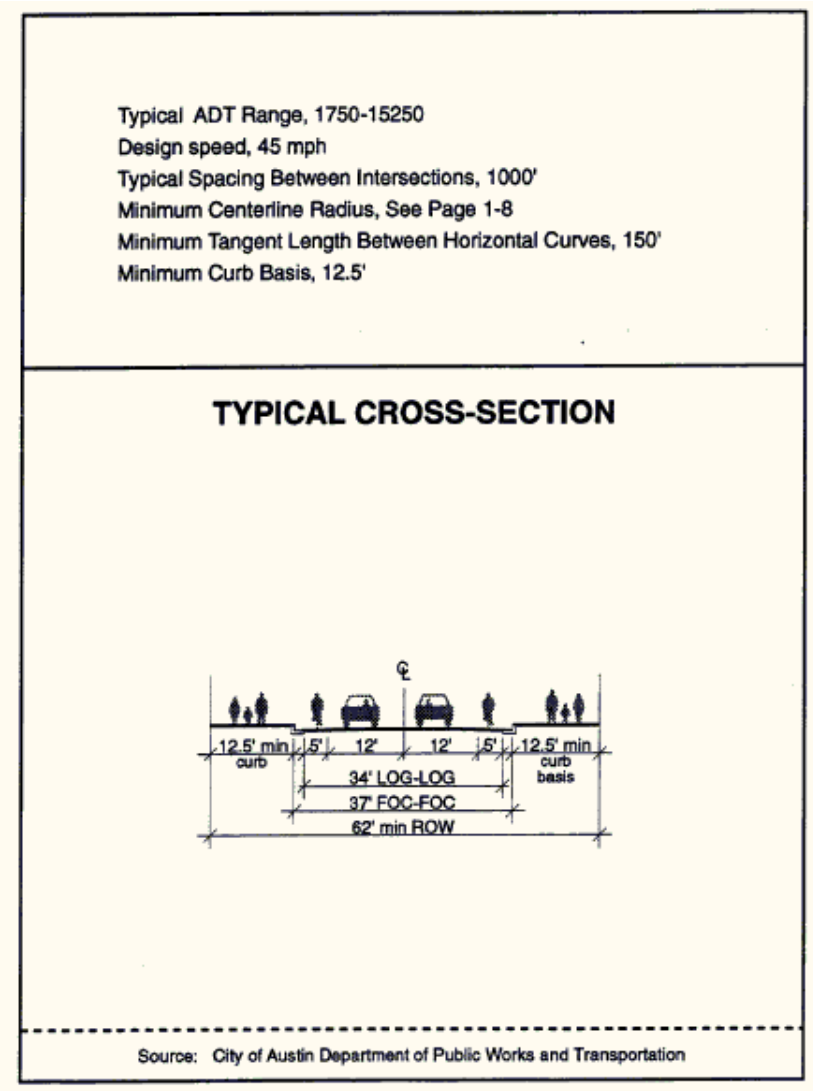



FIGURE 1 – 34B Alternate design for 2 lane minor arterial

**Figure 1 – 35A Minor Arterial Roadway 4 Lane Design.**

This cross sectional view is for a four lane minor arterial roadway with wide outside travel lanes. The additional width of the outside travel lane is to provide for adequate clearance between bicycles and/or parked vehicles. Direct driveway access to residential properties is prohibited in this design. Limited driveway access for commercial developments is allowed. The City of Cedar Park proposes to apply this cross section as the standard width and right-of-way allocation for high volume minor arterial roadways where there is adequate right-of-way and large scale adjacent land development.

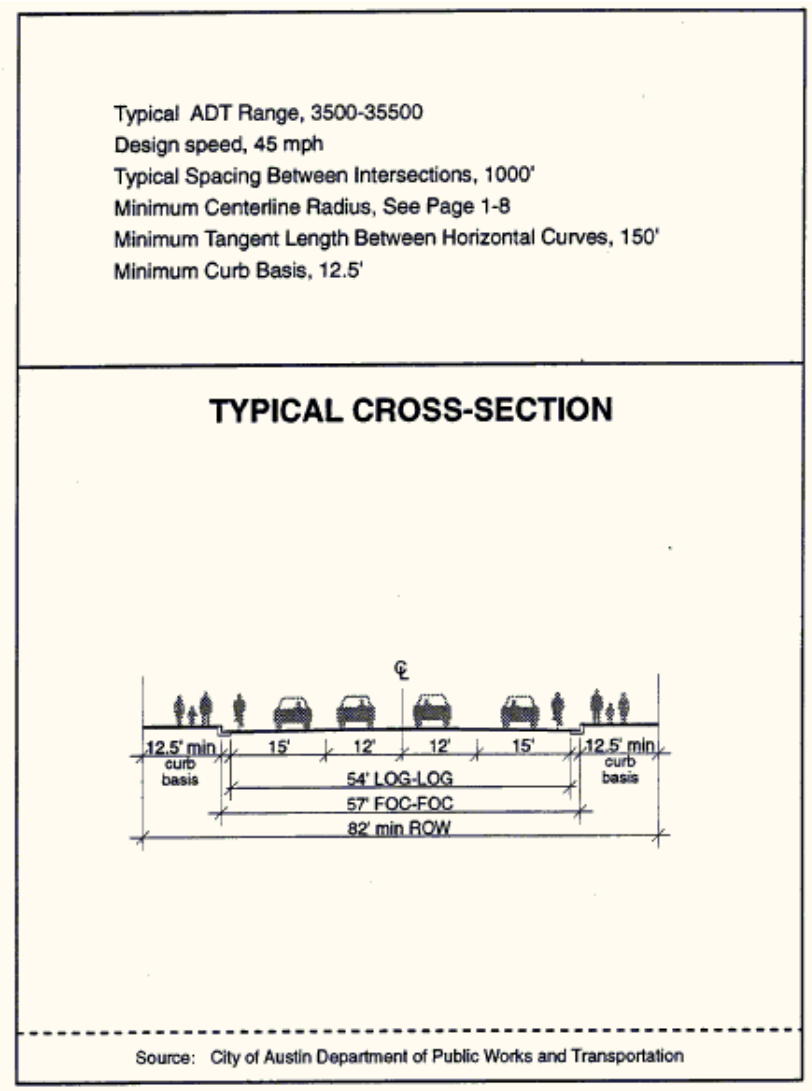



FIGURE 1 – 35A Cross section for 4 lane Minor Arterial

**Figure 1 – 35B Minor Arterial Roadway 4 Lane Design.**

This cross sectional view is for a four lane minor arterial roadway with striped bicycle lanes. The presence of bicycle lanes precludes on street parking. Similar to the proceeding figure, direct driveway access to residential properties is prohibited in this design. Limited driveway access for commercial developments is allowed. The City of Cedar Park proposes to apply this cross section as ion areas of constrained right of way with significant bicycling demand.

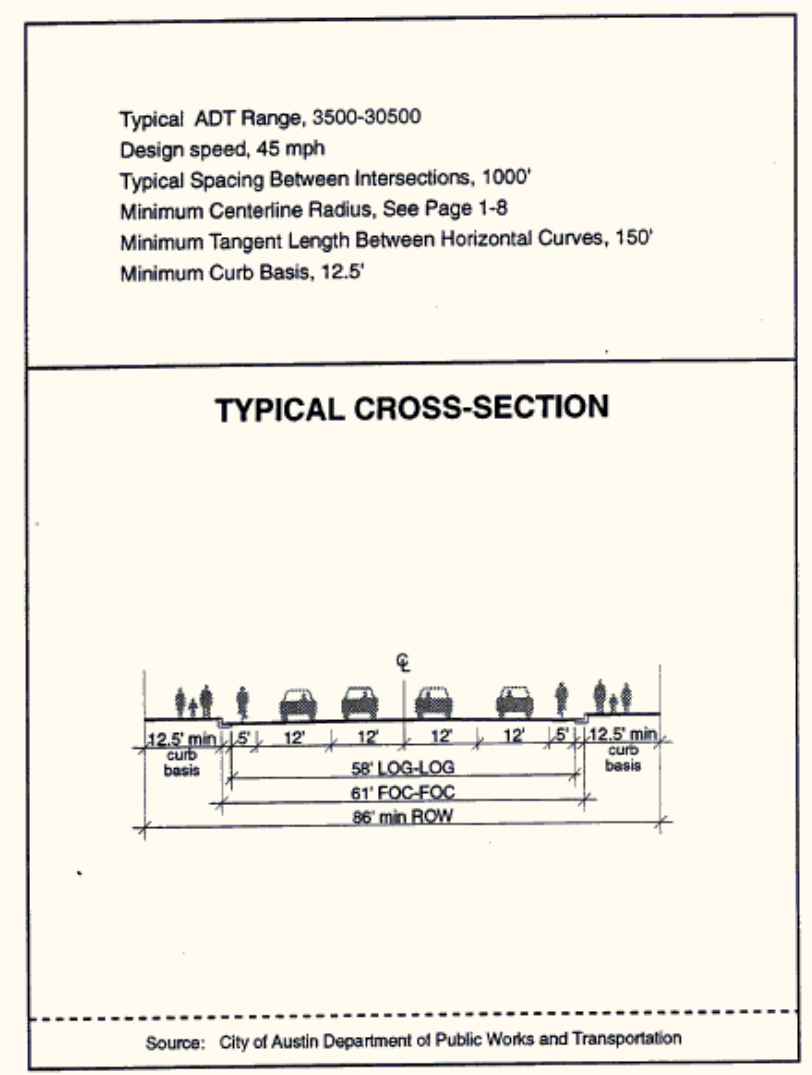



FIGURE 1 – 35B Alternate 4 lane Minor Arterial Cross Section

**Figure 1 – 37A Major Arterial Roadway 2 Lane Design.**

This cross sectional view is for a two lane major arterial roadway with a continuous center two-way left turn lane. The extra wide outside lanes are provided to accommodate bicycles. On-street parking is prohibited on major arterial roadways. This design is to be modified to alter the continuous center lane and replace it with centerline medians or alternative striping design. It is the intention of the City of Cedar Park to limit the installation of two-way center left turn lanes. This design is proposed for application in areas of constrained right of way with significant bicycling demand.

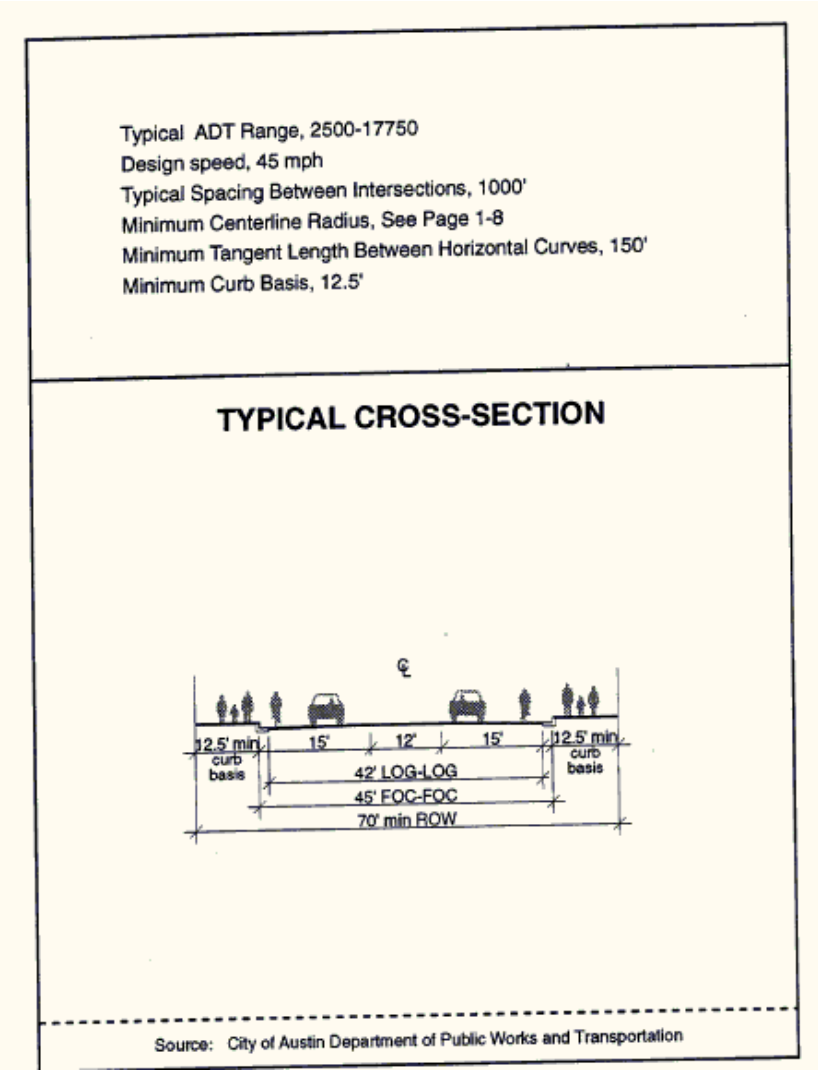



FIGURE 1 – 37A Cross section for 2 lane Minor Arterial Roadway

**Figure 1 – 37C Major Arterial Divided 4 Lane Design.**

This cross sectional view is for a four lane major arterial divided roadway with wide outside lanes and a centerline median. The presence of bicycle lanes precludes on street parking. Similar to the proceeding figure, limited driveway access for commercial developments is allowed. The City of Cedar Park proposes to apply this cross section in areas with adequate right of way and significant bicycling demand.

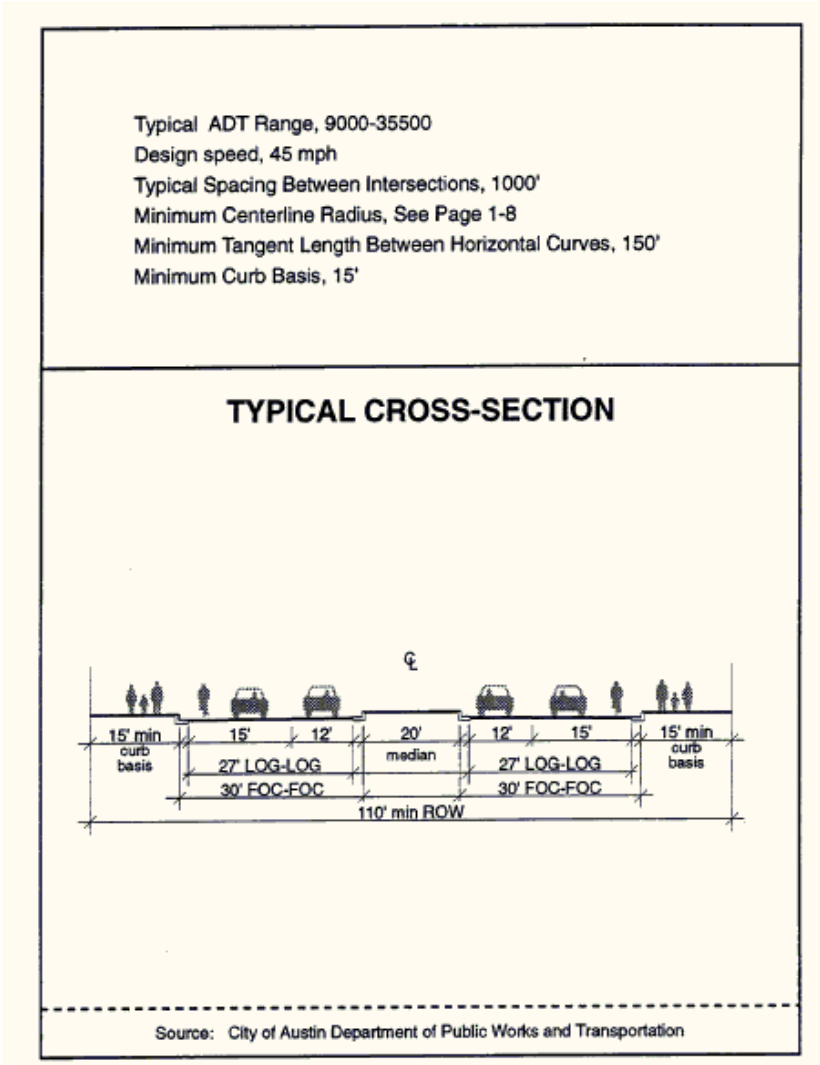



FIGURE 1 – 37C Cross section for 4 lane Minor Arterial Divided

## Sample Cross Section for 2 Lane Arterial Roadway with center median and no parking

Typical ADT Range: 2500 - 15000
Design Speeds 35 - 45 mph
Intersection Spacing: 1000 ft.
Minimum curb basis: 12.5 ft.
Minimum horizontal tangent length: 150 ft.

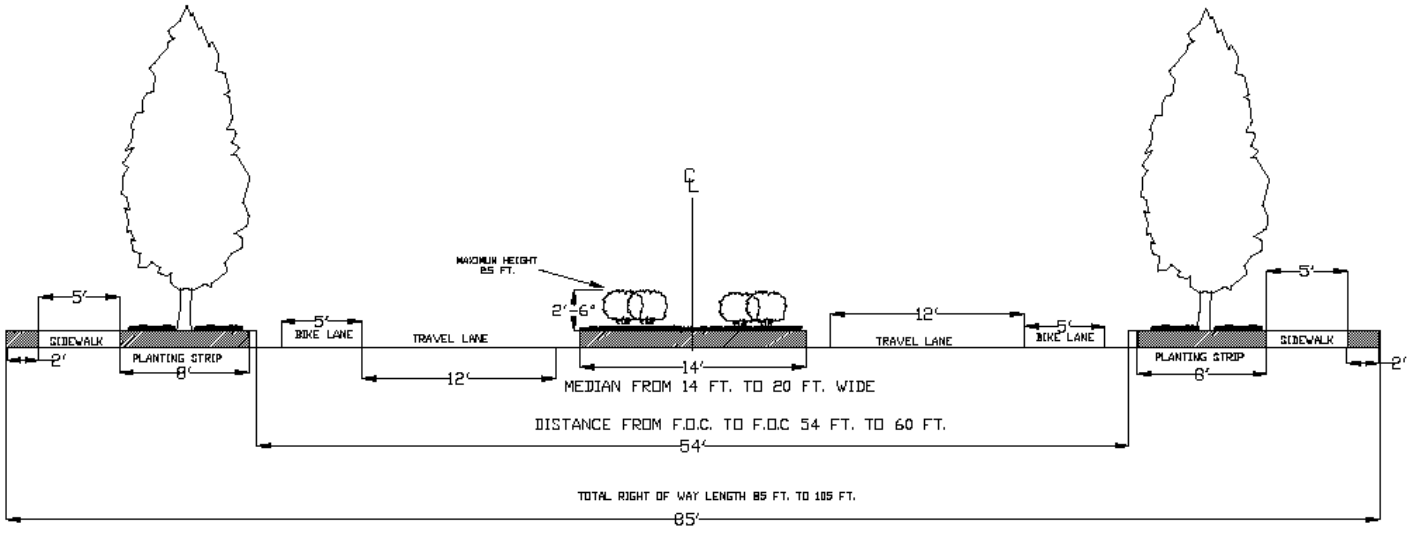



Figure TMP - 1

## Sample Cross Section for 2 Lane Arterial Roadway with median and on-street parking lane

Typical ADT Range: 2500 - 15000
Design Speeds 35 - 45 mph
Intersection Spacing: 1000 ft.
Minimum curb basis: 12.5 ft.
Minimum horizontal tangent length: 150 ft.

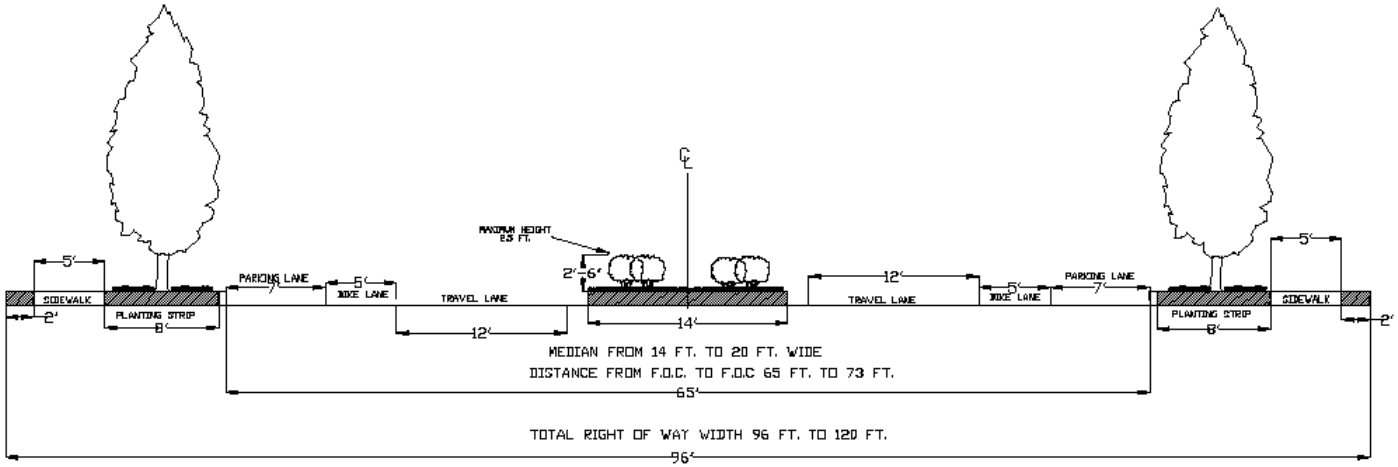



Figure TMP - 2

## Sample Cross Section for 4 Lane Arterial
## Roadway with center median and no parking lane

Typical ADT Range: 10000+
Design Speeds 45 mph
Intersection Spacing: 1000 ft.
Minimum curb basis: 15 ft.
Minimum horizontal tangent length: 150 ft.

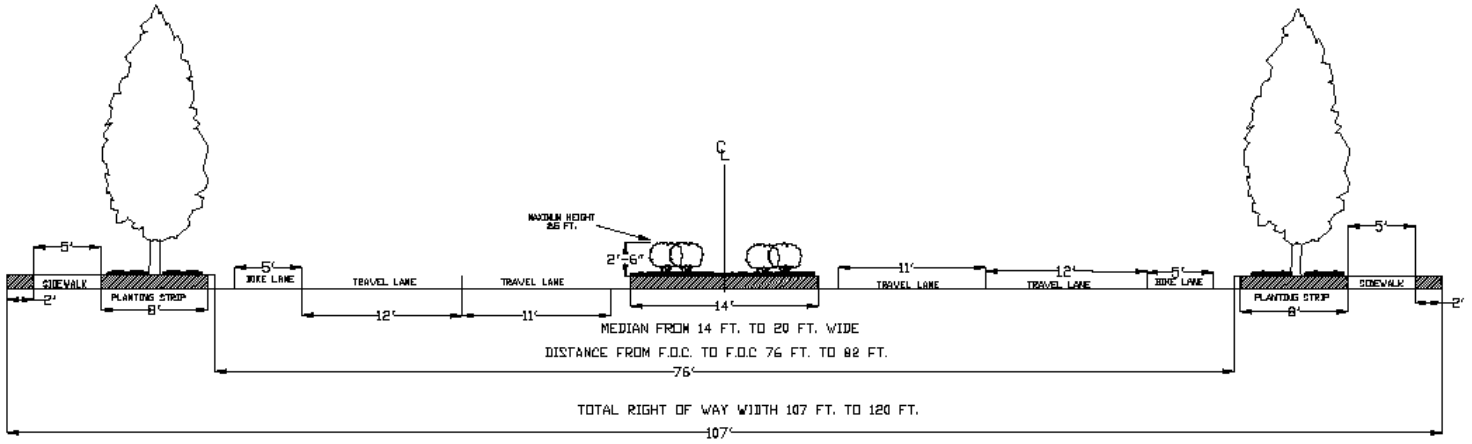



Figure TMP - 3

## Sample Cross Section for 4 Lane Arterial Roadway with center median, prohibited on-street parking and off road trail

Typical ADT Range: 10000+
Design Speeds 45 mph
Intersection Spacing: 1000 ft.
Minimum curb basis: 15 ft.
Minimum horizontal tangent length: 150 ft.

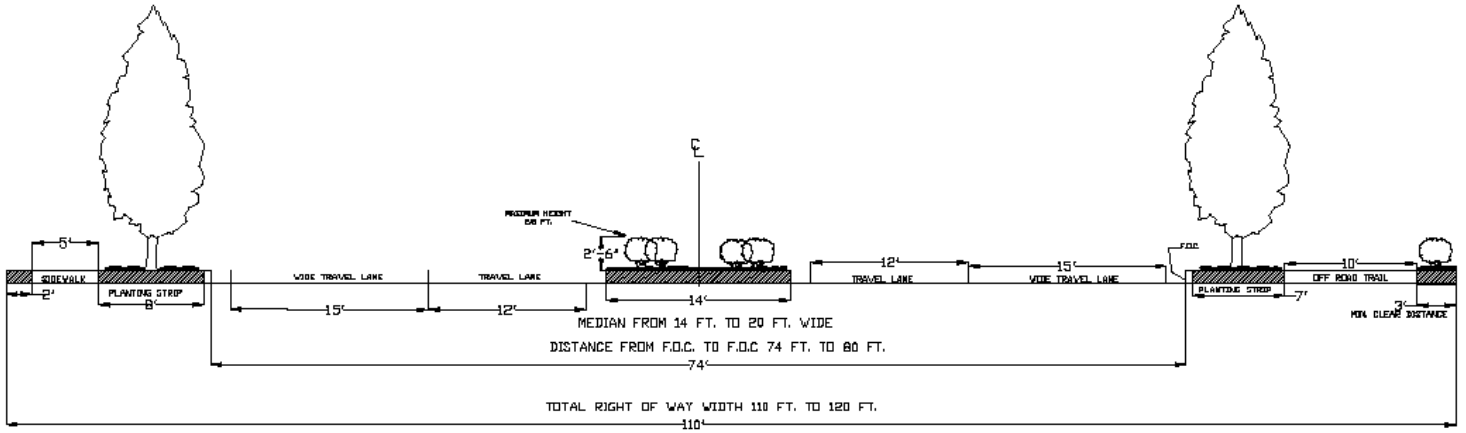



Figure TMP - 4

## Sample Cross Section for 2 Lane Arterial Roadway with center median, prohibited on-street parking and off road trail

Typical ADT Range: 2500 - 10000
Design Speeds 35 - 45 mph
Intersection Spacing: 1000 ft.
Minimum curb basis: 12.5 ft.
Minimum horizontal tangent length: 150 ft.

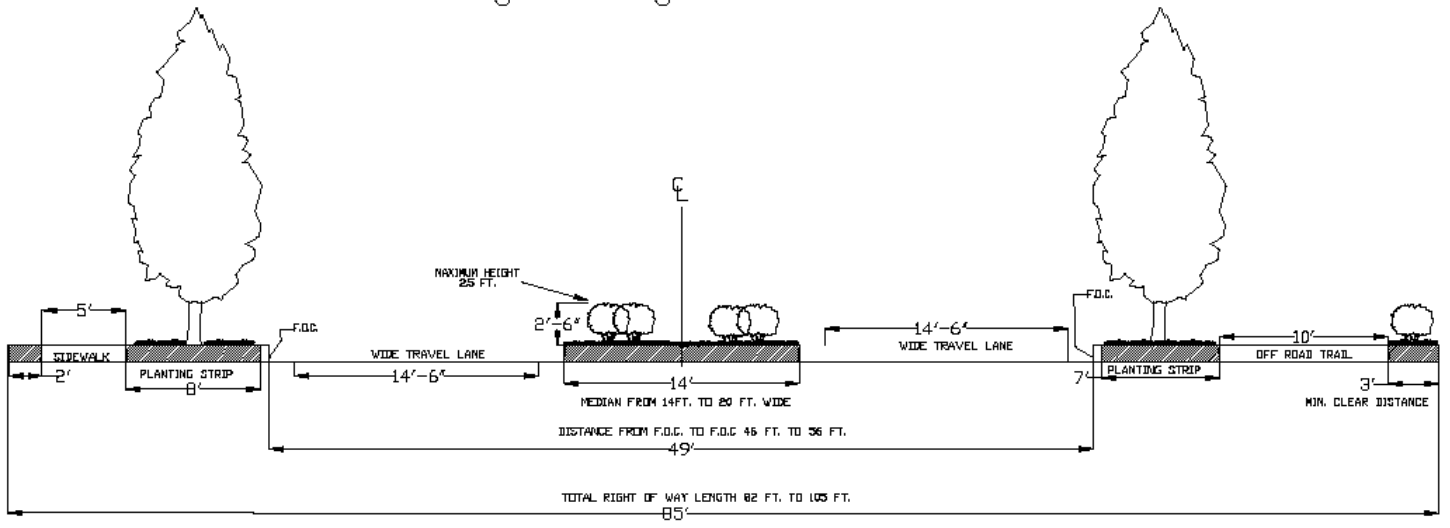



Figure TMP - 5

# APPENDIX C –
# TRAFFIC CALMING PRACTICES AND TECHNIQUES

**Traffic Calming Applications**

Broadly defined, the goals of traffic calming measures are:

- to slow down the average vehicle speeds for a particular roadway
- to address excessive volumes for a particular roadway
- to remind or reinforce the residential nature of specific roadways

Traffic calming measures are designed to slow down or impact all traveling vehicles. The following definition was taken from the 1999 ITE Report, Traffic Calming: State of the Practice.

"Traffic calming devices address problems of speeding and/or high volumes of cut through traffic on specific streets. Traffic calming devices are self-enforcing, cost-effective measures that can include aesthetic improvements to a roadway."

In application, traffic calming is used to assist and enforce existing traffic laws. Traffic calming devices can also be used to discourage aggressive driving or excessive volumes of traffic on residential streets.

**Objectives of Discussion**

The purpose of this section is to provide background information about the design, application, installation and management of traffic calming devices. Traffic calming devices can be applied to residential, commercial, and large volume roadways.

**Limitations of Traffic Calming**

Traffic calming is not the proper response for poorly designed or inadequate roadways. The applications of traffic calming devices should be limited to ***documented*** speed and volume traffic issues that directly impact the public safety and welfare of an identifiable region.

The effectiveness of traffic calming devices depends upon the specific location, design dimensions, and spacing of the devices. The cost of construction can vary with the degree and sophistication of landscaping installed. Whether for speeding vehicles or for cut through traffic; traffic calming devices can be useful, aesthetically pleasing, permanent additions to city streets.

**Traffic Calming Devices**

Traffic Calming Devices are divided into two broad categories: horizontal and vertical deflectors.

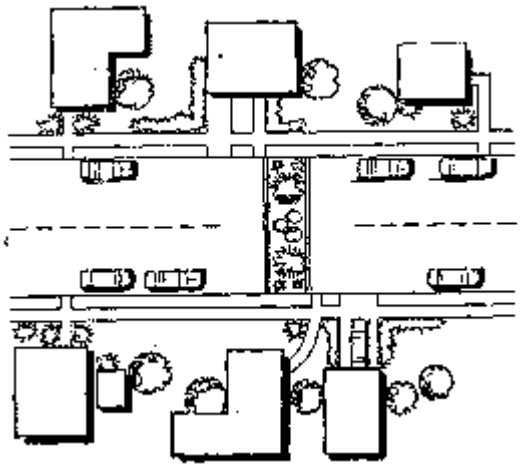
- Horizontal devices require some lateral movement(s) on the part of the vehicles to traverse the devices.
- Vertical devices do not prohibit movement, but instead require a reduction in speed, at which the device can be crossed without driver discomfort.

Multiple devices are used in series to address speeding and excessive volumes of traffic. All device types have some flexibility in design, allowing for more or less severe applications.

**Horizontal Traffic Calming Devices**

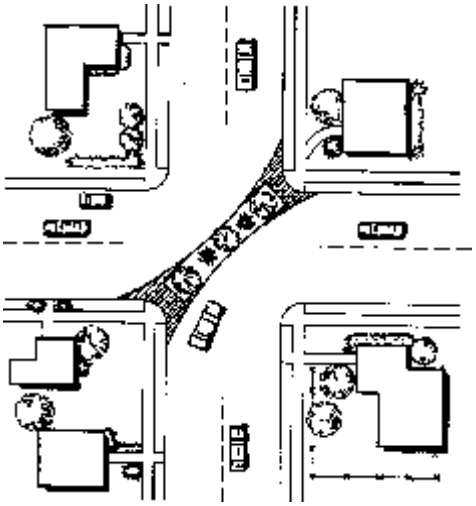
Some horizontal devices prohibit certain movements to address cut-through traffic concerns. Other devices are designed to reduce traffic speeds by requiring repeated lateral shifts from one lane to another. The following photographs and diagrams depict sample installations of horizontal traffic calming devices.

**Full Road Closure**



This device is the most stringent of anti-volume measures. A full road closure prohibits movement through the device entirely, except in certain instances for emergency vehicles. The traffic is forced to use alternative routes, which must be carefully identified prior to installation.

**Diagonal Diverter**



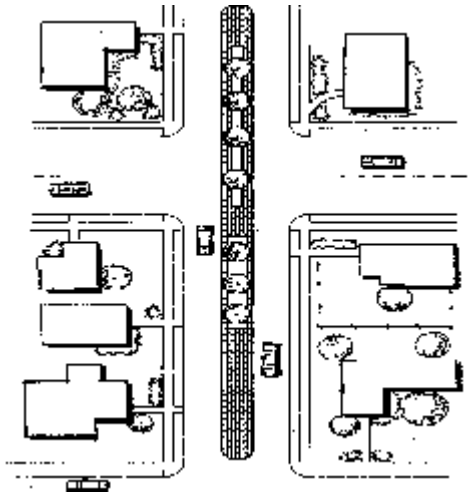
Similar to full road closures, diagonal diverters are high impact anti-volume devices. The diagonal diverter alters the access for traffic into right-angle movements and eliminates through access. Similar to complete road closures, the design can include emergency vehicle access via crash gates and/or mountable curbs.

**Partial Road Closure**

Partial road closures prohibit movement in one direction. Common designs constrict traffic flow and allow exiting movements from a neighborhood. Many designs include mountable curbs or other emergency access

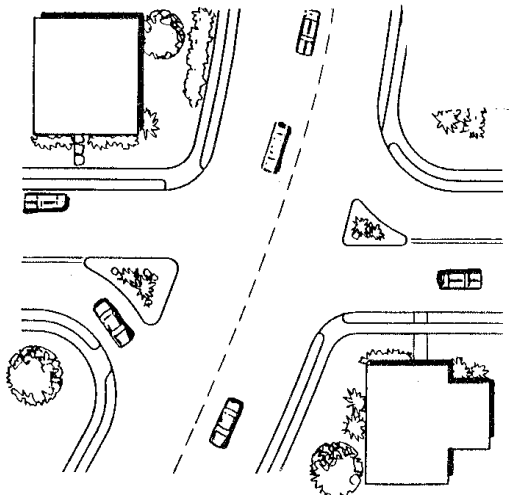
methods. The one shown above provides a separate channel for bicycles.

**Median Barriers**



For wide intersections, a center median barrier can be used to prohibit crossing movements exclusively. Similar to the partial road closure, access is denied in a specific direction, requiring an alternative route.

**Forced Turn Islands**



Forced turn islands require that vehicles entering an intersection perform a designated movement. In the case above, entering traffic is channeled north and south to prohibit through movements. Unlike median barriers, forced turn islands allow left-turn access from the main lanes and have lower construction costs.

**Residential Traffic Circles**

Residential traffic circles are placed primarily as anti-speed devices. The location of the circles is in the middle of the residential intersection that does not have an existing four-way STOP sign. The circle requires entering traffic to yield to vehicles already in the intersection and to travel counter-clockwise around the device. Traffic circles have proven very effective in reducing neighborhood speeds and discouraging through traffic.

**Chicanes**

Chicanes require vehicles to shift laterally the width of one lane to travel through the device. Chicanes are more effective when combined with centerline medians (see below) to avoid vehicles straddling the centerline.

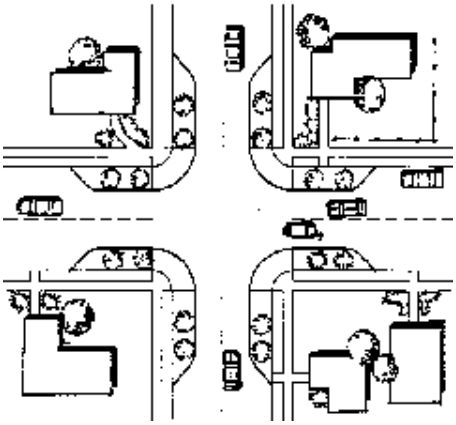
**Centerline Medians**

Centerline medians are designed to reinforce lane assignments, especially along constrained roadways. The median can serve as a slight speed reduction device, or to discourage speeding on dangerous curves.

**Centerline Median and Pedestrian Refuge**

Medians can be placed near or at intersections to provide assistance for pedestrian access. For wide intersections, the location of a dividing median in combination with a crosswalk can play a large role in reducing the risk associated with pedestrian crossings.

**Intersection Bulb-outs**



Intersection bulb-outs can be placed to provide assistance for pedestrian access. The intersection is narrowed to shorten the total distance required to cross the travel lanes. An additional feature of the intersection bulb-out is the narrowing or elimination of travel lanes. When combined

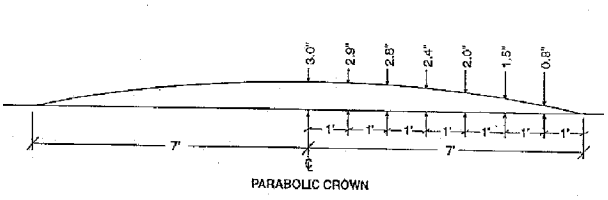
with parking bays, intersection bulb-outs can provide locations for landscaping.

**Vertical Traffic Calming Devices**

This category of traffic calming devices uses designs that cause driver discomfort at higher than desired speeds. These devices can be designed for any number of traveling speeds, depending upon the slope of the approach and overall dimensions of the device. The most common application of vertical devices is along residential streets with long straight sections and gradual slopes.

**Fourteen-foot Speed Humps**

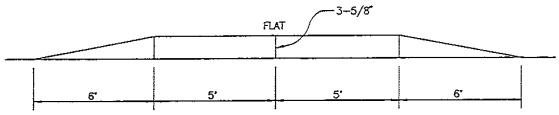
Speed humps are designed to cause driver discomfort when traversed at speeds higher than the posted speed limit. The hump approaches can be altered to create more or less severe slopes, resulting in greater reduction in average travel speeds. The height of a vertical deflection device is between 3 and 4 inches above the original roadway surface.




Side view of typical 14-foot speed hump

**Twenty-two Foot Speed Tables**

Due to the impact of the 14-foot speed hump for long wheelbase vehicles, some municipalities have opted to lengthen the hump while maintaining its height. The resulting hump is 22 feet in length and does not offer the same risk of scraping the bottom of long wheelbase vehicles. Speed studies have shown no significant difference between the effectiveness of the 14 versus the 22-foot speed hump designs.



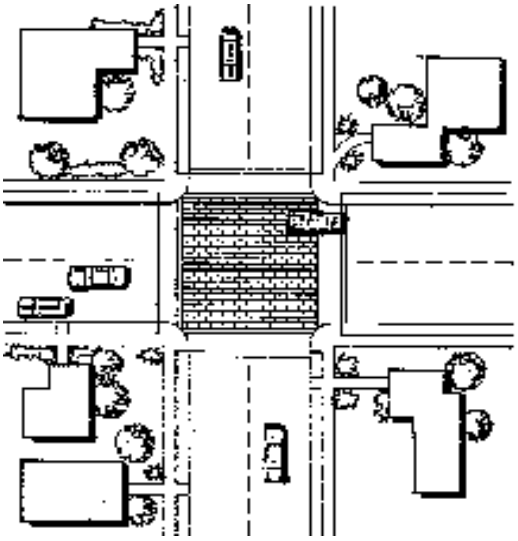

Side view of typical 22-foot speed hump

**Modular Speed Cushions**

Often called “turtle shells” or “speed pillows,” these sectioned devices are useful for placement along roadways that are used by emergency vehicles. The advantage of the device design is that wider wheelbase vehicles can partially straddle them and thereby decrease rider discomfort. Speed studies have shown the modular speed cushion design to be slightly less effective in reducing travel speeds than the full-length speed humps. As shown in the following photo, speed cushions can be combined with centerline medians to reduce travel speeds while narrowing a roadway.

**Cushions with Centerline Median**

**Raised Intersections**



For intersections with large volumes of pedestrians or commercial development the entire intersection can be raised to provide greater visibility for crossing pedestrians. The dimensions of the raised intersection are similar to those of other vertical devices, with the overall height approximately 3 to 4 inches above the travel surface. Several

installations have included extensive landscaping.

**Raised crosswalks**

Instead of raising the entire intersection, only the crosswalk locations can be raised to serve large pedestrian volumes. The dimensions of the raised intersection are roughly the same as those of the 22-foot wide speed table. Each approach ramp is 6 feet in travel length, with the center of the crosswalk approximately 10 feet wide.

**Combined measures**

The effectiveness of a traffic calming device can vary according to severity of approach angles, spacing between devices, advance signage, and variety of designs. Some of the most effective installations have used combined elements such as speed humps before and after chicanes, raised medians in combination with speed cushions or elevated crosswalks. The placement of advance signage and brightly painted roadway markings can also improve the effectiveness of the devices.

**Implementation Techniques**

Choosing and installing traffic calming devices can become a political and emotional issue. In the interests of using a scientific method of evaluation, several agencies review the benefits (and costs) of specific devices prior to recommending them for specific traffic concerns.

**Proper Application of Devices**

Foremost in the selection of traffic calming devices is identifying the problem. To address speeding concerns, vertical deflection devices have proven most effective. However, certain horizontal devices such as chicanes and centerline medians have been used to reduce travel speeds. Traffic calming devices should be positioned no closer than 400 feet apart. Studies have shown that spacing devices further than 800 feet apart reduces their effectiveness.

To address cut through traffic volumes, horizontal devices are most effective. In particular, if there is clear evidence of "shortcutting" through a neighborhood, partial or complete road closures may be used. Often, partial closures and diverters in one location are sufficient. The location and number of anti-volume devices depend upon the need to provide access and the amount of through traffic to be addressed.

Not every location has speeding or volume concerns due to external commuter traffic. Often neighborhoods complain about external traffic only to learn later, via data collection, that the residents themselves are the source of the speeding vehicles. In

these instances, the use of anti-volume devices is unwarranted as all traffic (or a considerable percentage) is "internal."

**Recommended Devices Thresholds**

Certain devices are more severe than others. Following are tables summarizing recommended thresholds and applications for specific devices. The thresholds provided are derived from several municipal traffic calming programs. Please note that each device type can be designed for a given roadway width, slope and length. The spacing of device(s) can be altered to provide more aggressive reduction in overall speeds, as necessary.

**Table 1 – Overview of Horizontal Devices**

| Device Name | Target Volume | Target Speed (mph) |
|---|---|---|
| Chicane | 1000+ | 20 – 25 |
| Centerline Median | 1500+ | N/A |
| Intersection Bulbout | 20 peds | 0-15 |
| Forced Turn Islands | 500-1000+ | 15 – 25 |
| Median Barriers | 1000+ | N/A |
| Partial Road Closure | 1500+ | N/A |
| Diagonal Diverter | 1500+ | N/A |
| Full Road Closure | 2000+ | N/A |

The above values represent the through traffic volumes and not the total street volumes. Therefore, in the case of diagonal diverters, it is recommended that an excess of 1500 vehicles be documented to warrant installation. These vehicles are above and beyond those using the road for local access. The value of "20 peds" refers to the minimum number of pedestrian crossings in a one-hour period to warrant installation.

**Table 2 – Overview of Vertical Devices**

| Device Name | Target Volume | Target Speed (mph) |
|---|---|---|
| Speed Hump/Table | 800+ | 20 |
| Speed Cushion(s) | 800+ | 22 |
| Raised Crosswalk | 20 peds | 0-15 |
| Raised Intersection | 50 peds | 0-15 |

The above values represent the documented through traffic volumes in support of recorded speeding violations. Therefore, in the case of speed humps or other devices, it is recommended that 800 vehicles be the minimum threshold to warrant installation. The value of "20 peds" refers to the minimum number of pedestrian crossings in a one-hour period to warrant installation.

Please note that the above values are not strict rules for application, but more for guidance in reviewing possible devices. Any traffic calming installation can be made ineffective with poor design, inadequate spacing or poor quality construction. Correspondingly, aggressive placement of speed humps, while not popular, can be very effective in reducing average travel speeds and (indirectly) discouraging through volume.

**Traffic Calming Plans**

Many municipalities have implemented traffic calming devices along single streets to address single complaints. One difficulty in this methodology is the shifting of traffic one block removed from the targeted route. For cities and towns with grid roadway systems, the problem street can become a 'moving target;' adjacent streets develop

similar travel patterns as the devices are installed.

Another drawback to this approach is the need for repeated construction bids or visits to the same general area of the city. Even if city personnel do the construction work, it is inefficient to visit the same location repeatedly in response to similar complaints.

Instead of reviewing each street as a single unit, many cities study an entire area for traffic calming and other transportation improvements. By examining all of the roads within a given study area, traffic calming installations can be more comprehensive.

The advantage of the comprehensive planning approach is its broader view of the neighborhood's traffic patterns. The "big picture" view of the traffic patterns will also help avoid shifting speeding traffic from one street to another.

**Neighborhood Involvement**

Most municipalities have more citizen complaints and locations for study than can be addressed by staff. To help organize the public's input as well as manage the number of requests for traffic calming, some cities divide their jurisdiction into service areas, each bounded by major arterials.

**Neighborhood Complaints Database**

A database with a record of each citizen complaint, including the address and concern (speeding, volume, school crossings, etc) should be created. The street and complaints database can be used to graphically portray the areas with the most activity, each area being determined by the boundary arterials.

On a scheduled basis, the most frequently requested regions in the city's jurisdiction are canvassed with traffic speed and volume counters to confirm (or refute) the complaints. Each funding cycle, a final list of candidate study areas is created using the data collected.

**Citizen Focus Group**

Within each service or study area, public input should be solicited, organized and compiled into a comprehensive traffic calming plan that addresses the key streets within the study area. A focus group of the concerned citizens can be created to review and draft the specifics of the traffic calming devices to be used. The overall plan can be mailed to the citizens living within the study area for public approval via postage prepaid ballots. A minimum percentage (51%-75% depending on the city) of the received votes must be in favor of the proposal to implement the entire traffic calming plan.

**Installation**

The installation of traffic calming devices is simple and can be done by most municipal crews. The majority of the devices are dimensioned to fit within small residential streets and require little in the way of traffic control. However, when many devices are to be installed or city resources are constrained, putting traffic calming projects

out to bid can save valuable resources. Most roadway construction and paving companies can install traffic calming devices.

**Trial Installations**

Trial installation of chicane with median

Many cities recommend using temporary elements to construct trial installations of traffic calming devices before building permanent versions. The temporary versions have the same dimensions and markings as the final design. Trial constructions provide an opportunity for the concerned citizenry to evaluate the size, look and operation of the devices.

**Landscaping Concerns**

Critical to traffic calming installations is the final appearance. Often, the residents near a device wish for aesthetic elements to enhance its attractiveness. Extensive landscaping can raise the price of an installation.

Should concerned citizens wish for detailed landscaping or other aesthetic elements (additional paint or signage beyond what is required), provisions should be made to allow citizen groups to contract and sponsor these additional services.

**Performance Measures**

Given that traffic calming devices are installed to address known (and well-documented) traffic problems, there is ample opportunity to review and learn from past experience.

Before and after comparisons should be performed detailing public input, conflicts, and construction or landscaping issues for future reference. These records will become a valuable resource file for future projects. Where possible, final target speeds for specific roadways should be verified, especially where there are numerous public complaints on file.

**Removal of Devices**

During the trial installation period is an opportunity to receive feedback from the affected public. In the event that either the trial constructions or the permanent devices prove unpopular, unsafe or ineffective, some mechanism for their removal should be in place. The means for removing traffic calming devices should closely parallel those for requesting and implementing them. Traffic calming programs that are petition driven often use the same process for removal, except in the case of clearly unsafe designs or repeated accidents.

**Impacts to Emergency Services**

Any device or object that slows or diverts regular traffic also slows and diverts

emergency vehicles. Sometimes the oversize dimensions of emergency service vehicles mean that they are more severely impacted by the traffic calming devices than private vehicles.

To avoid unduly affecting their EMS departments, many municipalities involve representatives from several public safety agencies during the review of traffic calming devices. The selection of mountable curbs, crash gates or other permeable barriers instead of fixed objects can help address concerns over emergency access.

In addition, new device designs such as speed cushions and variable width partial closures can help provide reasonable access for EMS, while encumbering routine traffic. The best approach to the traffic calming discussion is for emergency services personnel to be consulted prior to any final decisions.

**Develop Primary Response Route Maps**

Many cities have developed primary response route maps for their EMS services. The EMS route map takes precedence and prohibits or restricts the type and amount of traffic calming devices to be placed on the identified roadways. EMS can also send representatives to public meetings to discuss the likely impacts to response times.

## *Resources*

The following list of resources provides valuable information on traffic calming devices, applications and programs. Several local and municipal governments have placed information about their traffic calming policies on the Internet.

**Municipal Traffic Calming Programs:**

Howard County, MD
www.co.ho.md.us/spdcntrl.htm
City of Berkeley, CA
www.ci.berkeley.ca.us/PW/traffic/trafcalm.html
City of Boulder, CO
www.ci.boulder.co.us/publicworks/depts/tr7.html
City of Portland, OR
http://www.trans.ci.portland.or.us/Traffic_Management/trafficcalming/
City of Seattle, WA
www.cityofseattle.net/td/trafcirc.asp
City of Tempe, AZ
www.tempe.gov/traffic/trafmgnt.htm

**Technical Papers and Discussions:**

US Department of Transportation Federal Highway Administration Traffic Calming
http://www.fhwa.dot.gov/environment/tcalm/

Canadian Institute of Transportation Engineers Neighbourhood Traffic Calming
http://www.cite7.org/traffic3.htm

International Institute of Transportation Engineers Traffic Calming website:
http://www.ite.org/traffic/index.html

# APPENDIX D –

# GLOSSARY OF TERMS

*The following terms and acronyms are widely used in the discussion of traffic and transportation engineering. In the interests of providing additional background information, this glossary of terms is presented for reference. The terms are listed in alphabetical order.*

**AASHTO** – American Association of State Highway Transportation Officials is a nonprofit, nonpartisan association representing all five transportation modes: air, highways, public transportation, rail and water. Its primary goal is to foster the development, operation and maintenance of an integrated national transportation system.

**Access Management** – providing or managing access to land development while simultaneously preserving the flow of traffic on the surrounding road system in terms of safety, capacity, and speed

**Accessible Route** – per the ADA, a continuous route on private property that is accessible to persons with disabilities. There must be at least one accessible route linking the public sidewalk to each accessible building

**Actuated Signal** - a signal where the length of the phases for different traffic movements is adjusted for demand by a signal controller using information from detectors.

**ADA** – Americans with Disabilities Act, Public Law 336 of the 101st Congress, enacted July 26, 1990 prohibits discrimination and ensures equal opportunity for persons with disabilities in employment, State and local government services, public accommodations, commercial facilities, and transportation.

**ADT** – Average Daily Traffic refers to the measured (or estimated) number of vehicles traversing a specific point on a roadway during twenty-four consecutive hours

**Alley** – a narrow roadway that provides accessibility and service to individual land parcels

**APA** – The American Planning Association is a nonprofit public interest and research organization representing practicing planners, officials, and citizens involved with urban and rural planning issues.

**ASCE** – American Society of Civil Engineers is a professional organization representing all aspects of civil engineering, including transportation engineering.

**Alternative Pathway** - a design for a pedestrian facility along a roadway that is an alternative to an urban standard sidewalk with curb.

**Arterial Street** - any street classified as serving higher volumes of traffic with limited points of access per the recommended design guidelines of the Transportation Master Plan.

**AICP** – American Institute of Certified Planners is the professional and educational institute operated by the APA. Planners are certified when they have met specific educational and work criteria and passed the certification exam.

**Attached Sidewalk** - a sidewalk with one edge adjacent to the back of the street curb.

**Audible Pedestrian Signals** - pedestrian signal indicators that provide an audible signal to assist visually impaired pedestrians in crossing the street.

**Bikeway** – any facility (on street or grade separated) that is designated for the use of bicycles

**Buffer Zone** – an open space strategically placed between travel lanes. For example, buffer zones can be used between parking lanes and adjacent sidewalks or vehicle travel lanes.

**CAMPO** - Capital Area Metropolitan Planning Organization is the official Metropolitan Planning Organization (MPO) for the Austin, Texas metropolitan area. The purpose of CAMPO is to coordinate regional transportation planning with the State of Texas, three counties, nineteen cities, and the Capital Metropolitan Transportation Authority and to approve the use of federal transportation funds within the Austin metropolitan area.

**CIP** – Capital Improvement Project – a municipally governed improvement that adds to the City's infrastructure. Projects include new curb construction, gutters, sidewalks and public access ramps. Additionally, constructing storm drains, widening roads, installing and upgrading traffic signals, and improving roadway conditions by realigning, striping, and/or overlaying roads.

**Collector Street** – a street classified as providing access service and traffic circulation. Collectors may penetrate residential neighborhoods, providing connections to the arterial system.

**Commuter Rail** – Passenger rail service operating primarily on existing freight and/or intercity passenger railroad tracks. Trips are typically between or within metropolitan and suburban areas and occur during peak travel hours with limited stops.

**Comprehensive Plan** - a broad collection of goals, policies, and objectives intended to inspire, guide, and direct growth in the City.

**Congestion** – the restriction of or interference to normal free flow of traffic. Congestion increases with an increase in rate of traffic flow

**Connector Pathway** - a walkway, trail, stair or other pedestrian facility not situated along a street. This may occur as a pathway within a public right-of-way where no street has been built, in a public walkway easement on private property, or as a path in a park or other open space.

**Clearance Interval** - the length of time allotted for a traffic movement (vehicle or pedestrian) to clear the intersection. For example, the length of time that the DON'T WALK indication is flashing on a pedestrian signal indication is called the clearance interval.

**Continuous Path** – according to the ADA of 1990, a continuous, unobstructed pedestrian circulation path within a public sidewalk connecting pedestrian areas, elements and facilities in the public right-of-way to accessible routes on adjacent sites. The continuous path is similar to the "Accessible Route" on private property, but is subject to different guidelines.

**Crossing Treatment** - a physical treatment of a crosswalk to make it safer and more convenient for pedestrian travel; may include such elements as crosswalk markings, median refuges, or curb extensions.

**Cross Slope** (sidewalk) - the angle of the sidewalk perpendicular to the line of travel. According to the ADA of 1990, the maximum allowable cross slope grade is 2%.

**Crosswalk** - any portion of a roadway at an intersection or elsewhere that is distinctly indicated for pedestrian crossing. Where there are no pavement markings, there is a crosswalk at each leg of every intersection, defined by law as the prolongation or connection of the lateral lines of the sidewalks.

**Cul-de-sac** - a street closed at one end, usually with a circular bulb extension for turning movements.

**Curb extension** - an area where the sidewalk and curb are extended into the parking lane, usually in order to shorten pedestrian crossing distance. Also called “bulb-out” or “curb bulb”.

**Curb Radius** - the length of the radius of the curve where a curb turns a street corner.

**Curb Ramp** - a combined ramp and landing to accomplish a change of level at a curb in order to provide access to pedestrians using wheelchairs.

**Curb Zone** - the portion of the sidewalk that physically separates the sidewalk from the roadway.

**Demography** – the statistical study of human populations especially with reference to size and density, distribution, and vital statistics

**Detached Sidewalk** - a sidewalk that is separated from the curb by a linear planting strip.

**Dropped Landing** - accessibility element in which the sidewalk ramps down to a landing at street level. Used only where a standard curb ramp cannot be accommodated.

**ETJ** – Extra-Territorial Jurisdiction is an area of land that surrounds a municipality’s corporate limits. It allows the city to regulate planning and development activity as the area becomes urban and ultimately is annexed into the city.

**Fixed-time Signal** - a signal that operates on a regular fixed cycle and has no actuated phases.

**Freeway** – an expressway with extremely limited access. Freeways are intended to provide for high levels of safety and efficiency in the movement of high volumes of traffic at high speeds.

**Frontage Zone** - a linear portion of the Sidewalk Corridor, adjacent to the edge of the right-of-way (or property line).

**Fully actuated signal** - a signal where all signal phases are actuated. (See “Actuated Signal”)

**Furnishings Zone** - a linear portion of the Sidewalk Corridor, adjacent to the curb that contains elements such as street trees, signal poles, utility poles, street lights, controller boxes, hydrants, traffic signs, street signs, parking signs, parking meters, driveway aprons, planting strip, or street furniture.

**General obligation bonds** – taxable or tax-exempt bonds that are backed by the general "faith and credit" of the issuing entity to assure repayment of the bonds. These bonds can be issued

through public entities to assist in private development activities if they further the objectives of a particular agency.

**Grade separation** - the separation of a pedestrian facility from facilities for vehicular movement by placing the facilities at different vertical elevations. Examples include pedestrian overpasses and underpasses.

**Infrastructure** – the system of public works of a country, state, or region

**Intermodal** – involving transportation by more than one form of carrier during a single journey

**Intersection** - the area of a roadway created when two or more public roadways join together.

**ITE** – Institute of Transportation Engineers is an international professional organization created to serve individual member educational and scientific applications to the profession of transportation engineering.

**Landing** – the level area at the top (or bottom) of a curb ramp.

**Light Rail** – a metropolitan electric railway system characterized by its ability to operate single cars or short trains along exclusive rights-of-way at ground level, on aerial structures, in subways or, occasionally, in streets, and to board and discharge passengers at track or car-floor level. Also known as streetcar, trolley car, or tramway.

**Local Service Walkway** – pedestrian classification intended to provide safe and convenient access to local destinations such as residential neighborhoods.

**Local Streets** – streets serving residential developments with limited length and connectivity to higher volume streets. Local streets offer direct access to adjacent residential properties.

**Median Refuge Island** – a refuge island located between vehicle travel lanes.

**Midblock crossing** – a crossing treatment that occurs between intersections.

**MUTCD** – Manual on Uniform Traffic Control Devices, a publication of the Federal Highway Administration that establishes a national standard for placement, design and use of traffic control devices on all streets and highways.

**Parallel curb ramp** – ADA term for the element described in this guide as a “dropped landing,“ in which the sidewalk ramps down to a landing at street level. Used only where constraints prevent accommodating a standard curb ramp.

**Parking control** – the use of meters, signs or curb markings to indicate where on-street parking is and is not allowed.

**Pathway** – a pedestrian accessible walkway other than a standard sidewalk.

**Pedestrian** – a person afoot; a person operating a pushcart; a person riding on, or pulling a coaster wagon, sled, scooter, or similar such vehicle with wheels less than 14 inches in diameter.

**Pedestrian District** – districts characterized by dense mixed-use development with a concentration of pedestrian-generating activities.

**Recreational Trail** – a path or walkway not interconnected with the street system, such a parks and greenbelt corridors. Off-street paths are intended to serve both recreational uses and other trips, and may accommodate other non-motorized travel modes in addition to walking.

**Pedestrian Only Zone** – an environment set aside for the use of pedestrians only to access commercial districts, recreational facilities or to connect between adjacent destinations.

**Pedestrian signal indication** – the lighted WALK/DON'T WALK signal that indicates the pedestrian phase.

**Perpendicular curb** – ADA term for a curb ramp in which the slope of the ramp is perpendicular to the line of the curb. This guide uses the term "curb ramp' to refer to such elements. See also 'Parallel curb ramp' and 'Dropped landing.'

**Public Stair** – a public facility of more than three steps, either in public right-of-way or a public walkway easement, for the use of the public.

**Public Walkway Easement** – an easement granted by a property owner to the City for the purpose of providing public access to pedestrians. Construction and maintenance of the sidewalk or walkway facilities in the easement is the responsibility of the adjacent property owner.

**Refuge Island** – a raised island in the roadway that separates a crosswalk into discrete legs and provides a refuge for crossing pedestrians.

**Right-of-way** – an easement held by the City over land that allows the City to exercise control over the surface and above and below the ground of the right-of-way.

**RMA** – Regional Mobility Authority – an extra jurisdictional entity embodied with the privileges and rights to construct, operate and maintain toll funded roadways within a specific region.

**Running grade** (sidewalks) – the slope of the sidewalk or roadway along the line of travel.

**Semi-actuated signals** – signals where only some phases (usually the side street) are actuated. (See "Actuated signals.")

**Separated Sidewalk** – a sidewalk separated from the curb by linear planting strip that may include lawn or groundcover and street trees. (see "Detached sidewalk.")

**Sidewalk** – an improved facility intended to provide for pedestrian movement; usually, but not always, located in the public right- of-way adjacent to a roadway.

**Sidewalk Corridor** – the area located within the public right-of-way between the curb line of a street or roadway edge and the property line at the edge of right-of-way.

**Slip lane** – a lane provided for ease of right-hand turns at the intersection of arterial streets. In new construction, this is often accomplished by the use of a large turning radius and an intermediate refuge island for pedestrian crossings.

**Speed Studies** – data based observations documenting the travel speeds of individual vehicles using a specific stretch of roadway

**Splinter Island** – used to separate opposing lanes of traffic at the throat of a modern roundabout intersection treatment.

**Tactile warning** – a surface treatment, usually at a curb ramp or any unexpected edge such as a rail platform that can be detected with a cane by a person with vision impairment.

**T Intersection** – an intersection where one street ends at a through street, forming an intersection shaped like the letter "T".

**TCM** – Transportation Congestion Management - a systematic process for managing congestion within transportation systems with respect to travel times and enhancing the mobility of persons and goods.

**Telecommuting** – to work at home by the use of an electronic linkup with a central office

**Transit** – usually local transportation especially of people by public conveyance; or vehicles or a system engaged in such transportation

**TXDOT** – Texas Department of Transportation is responsible for transportation development, including transportation planning, design, right-of-way acquisition, construction oversight and maintenance in the state of Texas.

**Volume Studies** – data based observations of the number of vehicles or transportation trips using a specific facility

**Walkway** – a pedestrian facility, whether in the public right-of-way or on private property, which is provided for the benefit and use of the public.

**Warrants** – data based methods of evaluation to assist engineers and transportation professionals in the evaluation of traffic control measures for a given situation. For example, warrants are used in determining the need for signalized intersections instead of STOP signs.

**Widened shoulder** – a type of bicycle facility provided immediately adjacent to the roadway.